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A STUDY OF THE INSECT FAUNA OF A CONIFEROUS REFORESTATION AREA IN SOUTHEASTERN OHIO[1]

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INTRODUCTION

Considerable interest has recently been manifested in the reforestation of certain areas of southeastern Ohio. The outstanding projects have been conducted with coniferous trees. Scattered conifers have been present in this region for many years, but with more extensive and concentrated plantings the insect pest problem assumes a seriousness not present with isolated trees or very small plantings.

York Forest, a reforested area in Athens County, was selected for this study because of its convenience and representative character. A brief account of the history and make-up of the forest appears elsewhere in this paper.

Based on York Forest as being a representative reforested area in the region under consideration, the scope of this study has been to determine what insects of the coniferous association had established themselves in the area, the extent of their damage, the probable or possible sources from which they entered, and the possibilities of appearance of pests not now known to be present.

Weekly inspection trips were made during the spring, summer, and autumn months of 1932. Areas in which outbreaks of pests had occurred were visited each time, the progress of infestations was noted, and the entire forest was scouted for developments pertinent to this survey.

The writer wishes to express his appreciation of the assistance rendered in the investigation by the following: Dr. Wm. C. Stehr, under whose guidance the study was made; Dr.

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HISTORY AND MAKE-UP OF THE FOREST

The forest upon which this investigation was conducted is known as the York Forest located in the northwestern corner of Waterloo township, Athens County, Ohio. It is a reforestation project carried out by the Carbondale Coal Co. on a hilly area characterized by deep ravines and steep slopes. The soil is a sandy loam, and the slopes contained many gullies as a result of the erosive action following the removal of the original deciduous forest.

Reforestation activities were begun by planting the eroded areas to black locust and tulip poplar in 1906 as a reclamation measure. The preliminary work proved quite satisfactory, and the first conifers were planted in 1908. Practically all the planting was done during the spring seasons. Fall planting was tried but did not give satisfactory results. Planting was done annually from 1908 to 1928 inclusive, except in the year 1913.

The forest now consists of about 200 acres divided into two main portions—the older containing about 160 acres, and the newer about 40 acres. The newer planting was laid out with the aim of harvesting the timber, in contrast to a rather experimental and crowded system of planting in the older area where land reclamation was the chief object. The coniferous tree population averages about 8,000–9,000 trees per acre.

The coniferous species represented are as follows:

COMMON NAME	SCIENTIFIC NAME
White pine	*Pinus strobus*
Red pine	*Pinus resinosa*
Scotch pine	*Pinus sylvestris*
Jack pine	*Pinus banksiana*

Austrian pine.....*Pinus austriaca*
Southern longleaf pine.....*Pinus palustris*
Larch.....*Larix* spp.
Fir.....*Abies* spp.
Spruce.....*Picea* spp.
White Cedar.....*Thuya occidentalis*
Bald cypress.....*Taxodium distichium*

White pine, red pine, and Scotch pine are the most abundant trees in the forest.

INSECTS OF THE CONIFEROUS ASSOCIATION IN YORK FOREST

In the course of this investigation, a considerable number of insect species was found in the forest whose habits and ecology indicated that they were members of the coniferous forest association.

The following list includes only those species which are definitely members of this forest association, or importantly concerned with the life of the forest. The writer feels that the list is in no sense an exhaustive one, but it does contain many forms of vital importance to the planting. The identifications are to species in most cases.

Order Orthoptera
Family Gryllidae
Oecanthus pini Beutm.

Order Isoptera
Family Rhinotermitidae
Reticulitermes sp.

Order Neuroptera
Family Hemerobiidae
Hemerobius sp.
Family Chrysopidae
Chrysopa sp.

Order Hemiptera
Family Reduviidae
Pselliopus cinctus (Fab.)
Arilus cristatus (L.)
Family Ploiariidae
Emesaya brevipennis (Say)
Family Pentatomidae
Euschistus tristigmus (Say)
E. variolarius (P. de B.)
Brochymena quadripustulata (Fab.)

Order Homoptera
Family Cercopidae
Aphrophora parallela Say
Family Aphididae
Cinara sp.
Family Pylloxeridae
Adelges pinicorticis (Fitch)
Family Coccidae
Chionaspis pinifoliae Fitch

Order Coleoptera
Family Histeridae
Epierus regularis Beauv.
Family Coccinellidae
Chilocorus bivulnerus Muls.
Family Curculionidae
Cossonus corticola Say
Pissodes approximatus Hopk.
Family Cerambycidae
Monochamus confusor Kirby
Rhagium lineatum Oliv.
Leptostylus sexguttata Say
Family Scolytidae
Pityogenes punctipennis Lec.
Ips calligraphus Germ.

ORDER LEPIDOPTERA
Family Psychidae
Thyridopterix ephemeraeformis Haw.
Family Sphingidae
Lepara coniferarum (A. & S.)
ORDER DIPTERA
Family Syrphidae
Syrphus torvus (L.)
S. rectus (O. Sacken)
S. weidemanni Johnson

ORDER HYMENOPTERA
Family Ichneumonidae
Ophion bilineatum Say
Ophion sp. (near *idoneum* Vier.)
Anacharis sp.

The following paragraphs summarize the activities of the insects of the preceding list in York Forest.

Oecanthus pini Beutm. (Pine tree cricket).

All of the specimens of *O. pini* taken in York Forest were on *Pinus strobus*. They were found in considerable numbers on the trunks of the trees on cold mornings in the early fall. This insect lays its eggs in the twigs of the trees and thus no doubt causes some injury. According to Blatchley (1920) its injury may be offset by its beneficial activities in feeding on aphids and other insect pests.

Aphrophora parallela Say (Pine spittle bug).

During the midsummer season these spittle insects were abundant on the Scotch pine. However, they disappeared early and there was no evidence of any damage resulting from their activity. The determination was made by Dr. Herbert Osborn, who stated in a personal communication that it is spread over the whole coniferous area of the eastern United States.

Cinara sp. (Aphids).

Two small colonies of aphids were found on young Norway spruce. However, no further infestation by these insects was found, so they can not be considered serious pests at York Forest.

Adelges pinicorticis (Fitch) (White pine aphid).

This insect secretes a flocculent, waxy material which covers both insect and egg. By the end of the summer, the infestation of *A. pinicorticis* had become abundant in spots and gave evidence of becoming a serious pest. According to Houser (1918), "Pines attacked by this aphis become sickly, the needles turn yellow, limbs may die and occasionally the entire tree succumbs. As a rule, however, only the smaller trees die."

In an area in which both recently trimmed and untrimmed white pines, between the ages of fifteen and twenty years were growing adjacent to each other, it seemed that the trimmed trees were more frequently attacked by the adelgid and that the degree of infestation was, in general, heavier on the trimmed trees. Counts were made which verified these observations and the data are presented in Table I above as for Area I.

A total of 667 trimmed and 223 untrimmed white pines were examined for adelgid attack in Area I. The contrast is very marked

as will be seen by an examination of the figures of Table I. In the trimmed pine, 16.9% had a heavy infestation, while only 1.34% of the untrimmed pine had a heavy infestation. Of the trimmed trees, 15.3% had a medium heavy infestation, whereas only 4.49% of the untrimmed trees were so infested. Thirty-nine per cent of the trimmed trees had a light infestation and 43% of the untrimmed trees had a similar infestation. While 51% of the untrimmed trees were not infested, only 28.4% of the trimmed trees were free from infestation. It is interesting to note that most of the untrimmed trees attacked by the adelgid were at the edge of the fire lane separating the trimmed and untrimmed portions.

TABLE I.

Showing the Comparative Infestation of *Adelges pinicorticis* (Fitch) on Trimmed and Untrimmed *Pinus strobus*.

		Area I Trimmed White Pine	Area I Untrimmed White Pine	Area II Trimmed White Pine
Heavy Infestation	No. of trees	113	3	23
	Percent of Total	16.9	1.34	5.5
Medium Infestation	No. of trees	102	10	5
	Percent of Total	15.3	4.49	1.2
Light Infestation	No. of trees	263	96	67
	Percent of Total	39.4	43.05	15.9
Free	No. of trees	189	114	326
	Percent of Total	28.4	51.12	77.3
Total	No. of trees	667	223	420
	Percent of Total	100	100	100

By referring to Table I again, it will be noted that the trimmed white pines of the isolated plot, designated as Area II, were, on the whole, less frequently and less severely attacked than the trimmed white pines of Area I. There are several factors worthy of note in this connection. The trees of Area II are a few years older than those of Area I, and are also more widely spaced, allowing more sunlight to penetrate to the trunks. Further, Area I is on a gradual southeast slope and Area II is on a similar northeast slope. From the present data, these are the only apparent differences in the areas, but whether they actually affect the infestations of adelgids in any way can not be determined from the studies up to the present time.

When the adelgid infestation was at its height, syrphid larvae were numerous on the trunks of infested trees. Three species of adult syrphids, *Syrphus torvus* (L), *S. rectus* (O. Sacken), and *S. weidemanni*

Johnson were taken in the forest. Dr. R. C. Osburn, who made the identifications, stated in a personal communication that "these species are all aphid feeding," so, evidently, they are aiding in the control of the adelgid, but are not abundant enough to establish complete control.

Chionaspis pinifoliae Fitch (Pine leaf scale).

In York Forest, the occurrence of *C. pinifoliae* was very extensive among the older white pines and red pines. On these older trees the infestation was confined, for the most part, to the lower branches which were in the self-pruning process. Younger trees were rarely attacked. The pest is abundant enough to be considered one of the serious pests at York Forest.

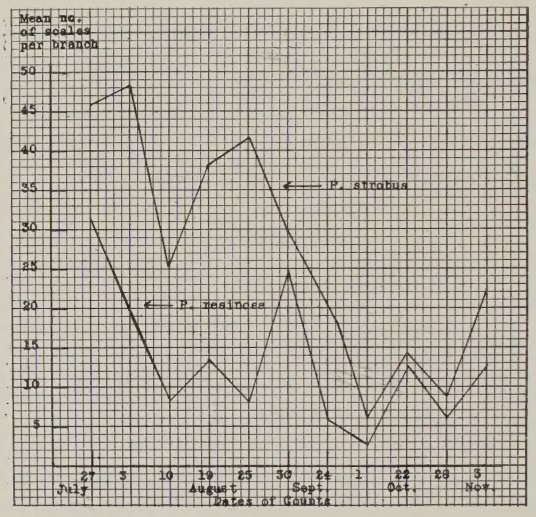

FIG 1. Mean number of pine leaf scales, *Chionaspis pinifoliae* Fitch, on terminal twelve inches of white pine, *Pinus strobus*, and red pine, *Pinus resinosa*, as determined by weekly counts.

During the summer and early fall months, weekly counts were made for the purpose of following the progress of the scale infestation. Counts were made of the number of scales on the terminal twelve inches of five branches located on various sides of each tree. The number of trees counted varied from eight to twenty and they were selected from various points throughout the area of infestation. The graphs of Figure 1 below show the seasonal progress of the scale as indicated by these counts.

Referring to the curves of Figure 1, it will be seen that the seasonal curve of the pine leaf scale has the same general form for both white pine and red pine. The rapid rise of the curves in August would seem to indicate the emergence of another brood and also to indicate that Houser's observation that there are two broods per year in Ohio is probably true in Southeastern Ohio unless the November rise indicates the emergence of another small brood. Generally speaking, the curve fell rapidly with the approach of autumn and consequent shedding of needles from the lower branches.

The twice-stabbed lady beetle, *Chilocorus bivulnerus* Muls., was fairly abundant on both white pines and red pines, and was observed actively feeding on the scales. However, the lady beetle was not sufficiently abundant to control the scale. The scale infestation has spread over a large part of the older planting, and there is a possibility of its causing considerable damage in the future.

Houser (1918) gives the following information concerning the seriousness of *C. pinifoliae:*

"The needles only of the host are attacked and when the infestation is only moderate no very serious results attend the pest. When the attack is severe, the needles become yellow and parts or the entire tree may die."

Cossonus corticola Say (Weevil).

C. corticola, a secondary pest, was common in the bark of dead pine trees in York Forest, but was of no especial importance except as a member of the coniferous association, working under the bark of dead timber.

Pissodes approximatus Hopk. (Weevil).

P. approximatus has been commonly confused with the very destructive *P. strobi* Peck, but was established as a separate species by Hopkins (1911). Of its list of hosts, *Pinus strobus* and *P. resinosa* are present in York and the insect was found beneath the bark of young trees of these species. It was not abundant, but may become a serious pest of young pines in the future.

Monochamus confusor Kirby (*notatus* Dr.).

The adults of this genus, known as "sawyers," deposit their eggs in the bark of dead and dying coniferous trees and logs. The larvae which work in the inner bark and sapwood were plentiful in dying white pines in York Forest. Their damage is of a secondary nature, rendering killed trees of this planting useless as lumber.

Rhagium lineatum Olivier (Ribbed pine borer).

Adults and larvae of this secondary insect were found beneath the bark of dead pine, a common habitat for it in West Virginia, according to Hopkins (1893b). Felt (1930) does not consider *R. lineatum* especially injurious.

Leptostylus sexguttatus Say.

Hopkins (1893b) does not list this Cerambycid borer from West Virginia. A few specimens were found beneath the bark of dead white pine in York Forest. Blatchley (1910) records this insect from Kosciusko County, Indiana, and adds that its occurrence there is "rare."

Pityogenes punctipennis Lec.

P. punctipennis was by far the most important beetle attacking young pines in York Forest. Six young white pines, thirteen young Scotch pines, and four young jack pines had evidently been killed by this bark beetle attack. None of these trees appeared to be more than ten years of age. Large numbers of adult *P. punctipennis* were present under the bark of these trees.

Thyridopterix ephemeraeformis Haworth (Evergreen bagworm).

In York Forest, this insect attacked arbor vitae and larch, but not in sufficient numbers to be considered a serious pest.

Lepara coniferarum A. & S. (Abbott's pine sphinx).

Only one specimen of this moth was taken, and no larvae at all were observed in York Forest. The larvae feed upon pine foliage.

Hemerobius sp. (Brown lacewings) and *Chrysopa* sp. (Green lacewings).

Throughout the summer months these lacewings were abundant in the planting. The brown lacewings were more abundant in the earlier part of summer and the green lacewings were more abundant in midsummer. The larvae of both of these genera are predaceous on aphids, scales and other small insects.

Emesaya brevipennis (Say) (Thread-legged bug).

This member of the family Ploiariidae was fairly abundant in York Forest. It is known to be a predator on small insects.

Pselliopus cinctus (Fab.).

Specimens of *P. cinctus* were taken frequently throughout the forest. They were actively running about over the trunks of the pines. This insect is known to be a predaceous form and was probably preying upon small insects found on the pines and other vegetation of the forest.

Arilus cristatus (L.) (Wheel-bug).

During this investigation, specimens of *A. cristatus* were observed frequently upon the pines where they probably aid somewhat in control of pests, although they possibly attack beneficial forms, too. According to Graham (1929) the nymphs of the wheel-bug are predaceous upon aphids and other small insects and as they mature they attack larger insects.

Brochymena quadripustulata (Fab.).

This "stink-bug" was abundant on white pine and Scotch pine and may have been feeding on sap. However, it is known to be predaceous on tussock moths and brown-tail moths. Felt (1908) records spruce and fir as being attacked by the white-marked tussock moth (*Hemerocampa leucostigma* A. & S.), and Houser (1918) reports this moth as doing damage in southern Ohio. In view of these facts, the presence of *B. quadripustulata* is worthy of note, even though the white marked tossuck moth was not found in York Forest.

Chilocorus bivulnerus Muls. (Twice-stabbed lady beetle).

C. bivulnerus was found in considerable numbers, feeding on *Chionaspis pinifoliae* Fitch. The seasonal progress of the scale showed that the lady beetle was not abundant enough to completely control the scale. However, the evidence shows that it is aiding in the control of the scale and must be considered of positive economic importance in the planting.

Syrphus spp. (Syrphid flies).

Throughout the spring and summer months, syrphid flies were abundant in York Forest. The species taken were *Syrphus torvus* (L.),

S. rectus (O. Sacken), and *S. weidemanni* Johnson. Dr. R. C. Osburn, who made the identifications, stated in a personal communication that all of these species are aphidophagus. Many syrphid larvae were found feeding on the adelgid, *A. pinicorticis* (Fitch), and, although they did not control the pest, they were undoubtedly aiding in its control.

Ophion bilineatum Say; *Ophion* sp. (near *idoneum* Vier.).

These Ichneumonids were quite abundant in York Forest during the summer, but no evidence of their parasitic habits was seen. However, R. A. Cushman states in a personal communication that they are parasites on lepidopterous larvae. Their abundance would make them valuable aids in controlling certain lepidopterous pests that might appear in the planting.

Anacharis sp.

This Hymenopteron was not as abundant as the above species. It was not observed parasitizing any other insects, but, according to information in a personal communication from L. H. Weld, they are parasitic on *Chrysopa* and *Hemerobius* larvae. Inasmuch as *Chrysopa* and *Hemerobius* are predaceous on harmful insects, *Anacharis* is evidently of negative economic importance in York Forest.

Reticulitermes sp. (Termites).

After the pine trees had died, termites were found mining in their trunks. They may be considered of negative economic importance in this forest because their activity contributes toward making the wood unfit for utilization as lumber.

Euschistus spp. (Stink-bugs).

E. tristigmus and *E. variolarius* were fairly abundant in York Forest. They feed on various weeds and vegetables, but there was no evidence of their attacking the pines.

Epierus regularis (Beauv.) (Hister beetle).

This histerid beetle was present in small numbers under the bark of dead trees. Blatchley (1910) says it feeds on fungi and since there is always considerable fungus under such bark, this no doubt explains the presence of beetles.

Camponotus sp. (Carpenter ants).

After the death of the pine trees, evidences of the work of carpenter ants were noted in the trunks. They contribute to the destruction of the tree trunks and make the dead timber unfit for lumber.

ECOLOGICAL SUCCESSION OF INSECTS IN PINUS STROBUS

The observations at York Forest have made it possible to determine the ecological succession in the white pine, *Pinus strobus*, growing in this area.

It seems that younger pines, less than ten years of age are seldom attacked by insect pests in York Forest. Most of

the attacks occurred on the older trees of the planting between the ages of fifteen and twenty years. The trunks of these trees varied in diameter from three or four inches to ten or twelve inches, and there seemed to be no correlation between the size of the trunk and insect attack.

Evidently, the first attack is made by the bark beetle, *Pityogenes punctipennis* Lec., followed a short time later by the weevil, *Pissodes approximatus* Hopk.. and the borers *Leptostylus sexguttata* Say, *Monochamus confusor* Kirby, and *Rhagium lineatum* Oliv. At a still later stage, *Ips calligraphus*

FIG 2. Location of southeastern Ohio with reference to main coniferous areas of eastern United States.

Germar and *Cossonus corticola* are in evidence. Shortly after, the histerid beetle, *Epierus regularis* Beauv. is active under the bark, feeding upon the fungus present there. Still later, carpenter ants, *Camponotus* sp. and white ants, *Reticulitermes* sp. begin work in the trunk. When the trunk is reduced to a mass of debris, centipedes and spiders are active, probably feeding upon various small organisms seeking food and shelter in this material.

COMPARISON OF THE INSECT FAUNA OF YORK FOREST WITH THAT OF OTHER CONIFEROUS AREAS

Reference to Figure 2 will show that southeastern Ohio lies near the center of a loop formed by the coniferous areas on the north, east, and south of Ohio, and insects coming into York Forest might originate from one or more of these areas. Table II has been prepared on the basis of data obtained from the works of Hopkins (1893a, 1893b, 1909), Felt (1930), Peirson 1927), Houser (1918), Blackman (1922), Blatchley (1910), Blatchley and Leng (1916), and Craighead and Middleton (1930). This table shows the principal coniferous insect pests in the above areas, their distribution, hosts, type and extent of injury, and the possibility of their occurrence in southeastern Ohio and York Forest if they are not already present.

Sixty-five insect pests are listed in Table II, the ranges of which are principally northern and northeastern, many of them extending into West Virginia. Ten of these pests, indicated by the letter "y", are definitely established in York Forest and an eleventh is present in Athens County.

Referring again to the distribution records of the species in Table II, it will be noted that thirty-eight species not taken in York Forest, have such distribution records as to render their occurrence in this section of Ohio probable either now or at some future time. These species are indicated by the letter "a" in the table.

The white-marked tussock moth, *Hemerocampa leucostigma* S. & A., is present in Athens County, but was not observed in the York planting.

Other insects that will probably appear here are the bark-beetles *Dendroctonus valens* Lec., *D. tenebrans* Oliv., *Ips grandicollis* Eich., and *I. caelatus* (Eich), the very serious white pine weevil, *Pissodes strobi* Peck., and the destructive pales weevil, *Hylobius pales* Boh. These are recorded from West Virginia by Hopkins (1893a, 1893b) and Blatchley and Leng (1916).

Further examination of Table II shows certain pests, indicated by the letter "b", that are not now in the immediate vicinity of southeastern Ohio, but which may find their way into this region. This group includes the Nantucket pine moth, *Rhyacionia frustrana* Comst., a pest of young pines, the bark-beetles *Ips avulsus* (Eich.), *Ips pini* (Say), and *Pityophthorus pulicarius* Lec., the weevils *Pissodes similis* Hopk. and *P dubius* Rand., and the borer, *Buprestis maculiventris* Say.

TABLE II.

THE PRINCIPAL CONIFEROUS INSECTS PESTS OF EASTERN NORTH AMERICA.

Species	Hosts	Type and Extent of Injury	Distribution	Possible Occurrence in S. E. Ohio
ORDER HOMOPTERA				
Family Coccidae				
Chionaspis pinifoliae Fitch	Pines, spruces	Scale insect on needles	Most of Northern U. S.	y
Family Phylloxeridae				
Adelges pinicorticis (Fitch)	White pine	Sap feeder on trunks	Northern U. S. to Minn.	y
Adelges abietis (L.)	Spruces, fir	Gall former	Range of spruce and fir	a
Adelges cooleyi (Gillette)	Spruce, fir	Gall former	Range of spruce and fir	a
Family Cercopidae				
Aphrophora parallella (Say)	Hard pine	Suck juices of leaves	Coniferous area of eastern U.S.	y
ORDER COLEOPTERA				
Family Buprestidae				
Chrysobothris azurea Lec.	Pine	Bark and wood borer, dead trees	West Virginia and Indiana	a
Buprestis maculiventris Say	Spruce	Borer	Indiana, Northeastern U. S.	b
Chalcophora virginiensis Drury	Pine, spruce	Borer	Eastern and Central U. S.	a
Chalcophora liberta Germ	Pine, spruce	Borer	Eastern and Central U. S.	a
Family Cerambycidae				
Prionus laticollis Drury	Pine stumps	Borer	West Virginia and Indiana	a
Asemum moestum Hald	Pine, spruce	Borer	Eastern U. S. and W. Va.	a
Phymatodes dimidiatus Kirby	Spruce	Bark borer	West Virginia	a
Callidium antennatum Newm.	Pines	Wood borer, dead & dying trees	West Virginia and Indiana	a
Rhagium lineatum Oliv	Pines	Bark borer, dead & dying trees	West Virginia and Indiana	y
Monochamus scutellatus Say	Pine	Wood borer, logs, dead and dying trees	West Virginia and Indiana	a
M. confusor Kirby	Pine, spruce	Borer in logs and dying trees	Can., N. Eng. and Middle States	y
M. marmator Kirby	Pines	Borer, kills living fir trees	N. Eng., W. Va.	a
M. titillator Fab	Pine, fir	Borer	N. Eng., Ind., W. Va. and S. E. U. S.	a

TABLE II—Continued.

Species	Hosts	Type and Extent of Injury	Distribution	Possible Occurrence in S. E. Ohio
Family Pythidae				
Pytho niger Kirby	Pine, spruce	Bark borer, dead & dying trees	West Virginia	a
P. americanus Kirby	Pine	Bark borer, logs	West Virginia	a
Family Curculionidae				
Pissodes strobi Peck	Pine, spruce	Bark borer, young, living and dying trees	Northeastern U.S., W.Va., Ohio	a
P. approximatus Hopk	Pines	Larvae live in bark of saplings	Eastern U. S.	y
P. affinis Rand	White pine	Weevil lives in bark of stumps	Northern U. S.	?
P. similis Hopk	Fir	Infests branches	Maine, N. H., N. Car	b
P. dubius Rand	Fir	Barks, living and dying stumps, trees	Ontario, Maine to Michigan	b
Hylobius pales Boh	Pines	Feeds on inner bark	N. Eng. to Florida and Ind	a
Family Scolytidae				
Monarthrum fasciatum Say	Many conifers	Tunnels in wood, enemy of products	Quebec and Lake Superior to Florida, West Virginia	a
M. mali Fitch	Many conifers	Tunnels in wood and products.	Eastern U. S., Ontario to Fla.	a
Gnathotrichus metariarus Fitch.	Pines	Timber beetle, dying pine	Eastern U. S., Canada to Fla.	a
Pityogenes pullus (Zimm.)	Pines	Under bark of dying pine	S. Car., Mich., W. Va., N. Y., N. J., D. C	a
P. hopkinsi Swaine	White pine	Bark miner	Throughout spruce region of W. Va	a
Family Scolytidae				
Pityogenes punctipennis Lec	Spruce, fir, pine	Miner, green bark, top of living tree	Maine and Quebec to Mich, W. Va	y
P. plagiatus (Lec.)	Pines	Tops and branches	Miss, Fla., D. C	b
Pityophthorus annectans Lec	Pine	Bark beetle	Fla., W. Va., D. C	a
P. sparsus Lec	White pine, etc	Bark beetle, hastens death of trees	W. Va	a
P. pulicarius Zimm	Pine	Twig beetle	N. J. to Fla., Ill., S. Car	b
P. coniperda Schwarz	Pine cones	Cone beetle	Canada, Mich., Mass., Va., N. Y., Pa	b

TABLE II—Continued.

Species	Hosts	Type and Extent of Injury	Distribution	Possible Occurrence in S. E. Ohio
P. lautus Eich.	Pines	Mines under bark of branches and twigs	W. Va., Miss., Texas	a
Xyloterus scabriolus (Lec.)	Dying pines	Timber beetle	Quebec, D. C., W. Va., N. Y., New Mex	a
Dryocoetes autographus Ratz.	Spruce	Bark, hastens death of injured tree	W. Va	a
Ips grandicollis Eich	Pine, spruce	Bark beetle	Middle Atlantic, Southern and Western States	a
I. calligraphus (Germ.)	All pine	Bark beetle, hastens death of trees	Canada, Atlantic region to Mex.	y
I cacographus (Lec.)	Pines, spruce	Bark beetle, hastens death of tree	W. Va	a
I. pini (Say)	Pines	Bark, hastens death of injured and dying tree	Eastern U. S. and Canada	b
I. avulsus (Eich.)	Pines	Bark, hastens death of injured and dying tree	Southern U. S., Penn	b
I. caelatus (Eich.)	All pines, spruce	Bark, hastens death of dying trees	U. S. south to W. Va	a
Dendroctonus valens Lec	Pine, larch, fir	Bark beetle	Canada, New Eng., south to N. Car	a
D. tenebrans Oliv	Pines	Bark beetle, may be primary	N. H., Penn., Tex., Fla., W. Va.	a
D. piceaperda Hopk	Spruce	Bark beetle	Maine, Mich., N. H., Penn., Canada	?
Crypturgus pusillus Gyll	Pines, spruce	Bark beetle, hastens death of trees	Northeastern U.S., Can., W.Va.	a
Hylurgops glabratus Zett	Pines	Bark beetle, hastens death of trees	W. Va	a
H. pinifex Fitch	Spruce, pine	Bark beetle, hastens death of trees	Canada, New Jersey, Ohio	a
Polygraphus rufipennis Kirby	Spruce	Miner, important secondary enemy	Throughout spruce region, W. Va	a

TABLE II—Continued.

Species	Hosts	Type and Extent of Injury	Distribution	Possible Occurrence in S. E. Ohio
ORDER LEPIDOPTERA				
Family Tortricidae				
Cacoecia fumiferana Clem.	Spruce, fir	Defoliating larvae	Northern states, Canada	?
Family Lymantriidae				
Porthetria dispar L.	Most trees, pines	Defoliating larvae	Eastern and Middle West	a
Hemerocampa leucostigma S. & A.	Most trees, spruces, fir, larch	Defoliating larvae	Eastern U. S., Miss. valley	y
Family Psychidae				
Thyridopterix ephemeraeformis Haw	Cedar, larch	Defoliating insect	Ohio, Eastern U. S.	y
Family Olethreutidae				
Rhyacionia buoliana Schiff.	Most pines	Defoliating larvae	N. Eng., Middle West, Ohio	a
R. frustrana Comst.	Pines	Defoliating larvae	Eastern and Southern States	b
Family Coleophoridae				
Coleophora laricella Hbn.	Larch	Defoliating insect	N. Eng., Lake States, Canada	b
ORDER HYMENOPTERA				
Family Tenthredinidae				
Diprion abbotti (Leach)	Pines	Defoliating insect	Eastern and East Central U. S., Ohio	a
Neodiprion leconti (Fitch)	Pines	Defoliating insect, kills trees	Eastern U. S. and West to Wis.	a
Family Formicidae				
Formica exsectoides Forel	Pines	Eject formic acid, kill trees	Northeastern U. S.	?
Camponotus herculeansis pennsylvanicus DeG.	Many trees, pines	Tunnel in living trees, logs, forest products	Throughout U. S.	y

There are a few pests listed in Table II whose distribution records make it seem unlikely that they will appear in southeastern Ohio in the near future. *Pissodes affinis* Rand., *Dendroctonus piccaperda* Hopkins, and *Cacoecia fumiferana* Clem. are examples.

In summarizing, we may say that the known distribution and habits of most of the sixty-five pests listed in Table II indicate that most of them are potential enemies of conifers in southeastern Ohio. Ten of these species have been taken at York Forest, and one other is known from Athens County. It is highly probable that still others are now present in this region. Most of the sixty-five species have been recorded from West Virginia. A close study of the table leads to the conclusion that West Virginia and southeastern Ohio are at a focal point for the meeting of the insect faunas of the northern and northeastern, and to a lesser degree, the southern coniferous areas of the eastern United States. Judging from present distribution records and duplication of the coniferous insect fauna of West Virginia and southeastern Ohio, it is probable that natural infestation of southeastern Ohio forests occurs frequently by migration from the West Virginia coniferous areas. This does not preclude the possibility of introduction of pests from other regions at greater distances by commerce in wood products of all kinds, Christmas trees, etc., or with young trees for reforestation.

GENERAL REMARKS AND CONCLUSIONS

This investigation has made it clear that a coniferous insect fauna is established in York Forest in which there are both harmful and beneficial species. Although the present study has been chiefly qualitative in nature, such quantitative data as have been accumulated show that several serious pests are at present doing considerable damage. An analysis of the insect pest fauna of the principal coniferous areas of eastern United States reveals numerous other injurious species which will probably migrate into southeastern Ohio and York Forest. It is evident that future reforestation activities in this area must take into account the insect problems that may arise.

The present data seem to warrant the following conclusions:

(1) Some thirty species of insects that are definitely members

of the coniferous forest association have established themselves in York Forest.

(2) Of these insects, the following pests are abundant enough to be of economic importance: *Pityogenes punctipennis* Lec., Adelges *pinicorticis* (Fitch), and *Chioaspis pinifoliae* Fitch.

(3) The following beneficial insects are present and aiding in control: *Chrysopa* sp., *Hemerobius* sp,. *Chilocorus bivulnerus* Muls., and *Syrphus* spp.

(4) The trees most seriously affected by insect attacks are *Pinus strobus* (white pine), *Pinus sylvestris* (Scotch pine), *Pinus banksiana* (Jack pine), in the order named.

(5) *Pinus resinosa* (red pine), *Larix* spp. (Larch), *Picea* spp. (Spruce), and *Abies* spp. (Fir) show little evidence of serieus attack by insect enemies.

(6) Quantitative counts reveal the fact that *Adelges pinicorticis* (Fitch) is probably the most widespread pest of white pine in the forest, and attacks trimmed trees more frequently than untrimmed trees in this planting.

(7) The pine leaf scale, *Chionaspis pinifoliae* Fitch, is abundant on the lower branches of older trees, and, while not now serious, may become a serious pest in the future.

(8) The ecological succession in insect attack of white pine seems to be initiated by *Pityogenes punctipennis* Lec., followed by various borers and bark beetles.

(9) A composite table has been prepared showing the pests of the principal coniferous areas of eastern North America.

(10) An examination of this table shows that there are many pests in those areas that are potential enemies of southeastern Ohio trees.

(11) A comparison of the insect fauna in York Forest with that of West Virginia reveals the fact that there is a duplication of coniferous insect pests. This suggests that further pests may be expected in this area soon.

(12) The present data indicate that future reforestation activities in southeastern Ohio must take into account insect pests as factors of importance.

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The Science of Colors.

This is a translation of the German edition of the treatise on color by the late Dr. Ostwald. It is a complete and unified theory of color standards and classification. It supplements but differs somewhat from the well-known theories of Helmholtz, von Bezold, Rood, Ladd-Franklin and the rest. The "color circle," a closed ring of saturated chromatic colors, is postulated. A "color solid," based on the application of Fechner's law, is constructed, in which all colors conform to the principle of "psychological equality" as expressed by the equation $C + W + B = 1$, where C = amount of full color, W = amount of white and B = amount of black. These three constants are substituted for the two older entities "purity" and "luminosity." The fact is demonstrated that three pigments are not sufficient for reproducing colors by printing, but that five is the smallest requisite number. The principles of color harmony are fully expounded in the clear and direct style characteristic of the entire book. Colored plates illustrating the standards of hue making up the color circle, a section of the color solid, representative isovalent circles, and the achromatic standards, are included.—L. H. S.

Colour Science, by Wilhelm Ostwald, translated by J. Scott Taylor. Part I, xviii + 141 pp., Part II, xii + 173 pp. London, Winsor and Newton, 1933. (In the United States, Winsor and Newton, Inc., 31 E. 17th St., New York City.)

PROTHETELY IN EPILACHNA CORRUPTA MULS. (COLEOP.)[1]

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Prothetely in larvae of holometabolous insects has been reported for single or few individuals, usually in cases of transfer from the field to the laboratory, where the unusual development became apparent. Observers in reporting on these individuals believe the change of environment responsible and list temperature, humidity, and cumulative quantities of carbon dioxide as possible causes.

FIG. 1. Prepupa of bean beetle showing wing pads.

Such abnormal larvae, in which precocious appearance of structures is visible (Fig. 1), have been occasionally observed in laboratory rearings and field collections of the Mexican bean beetle, *Epilachna corrupta* Muls., at Columbus, Ohio, over a period of three years.

Larvae with wing pads have been observed by the writers from three separate localities under field conditions. In the summer of 1933 at Columbus they occurred in field collections

[1]The writers are indebted to Dr. N. F. Howard, Mr. G. V. Johnson, and Mr. P. G. M. West for much of the material.

from June throughout the summer and as late as October 3. Samples of from 200 to 400 larvae taken from a 10-foot unit length of row yielded two prothetelic larvae on two occasions. In August a larva with wing pads was taken at South Point, Ohio, approximately 125 miles southeast of Columbus, and in September a similar individual appeared in a collection from Williamstown, W. Va. In February a larva with wing pads was found among larvae reared in a heated laboratory and in early June another was taken from larvae reared in a screened

FIG. 2. Prothetelic prepupa of bean beetle sloughing the last larval cuticle.

outdoor insectary. It is estimated that one larva with wing pads had appeared for each 10,000 larvae handled at Columbus during 1932 and 1933. Probably 25 individuals have been observed in all and in September 1933 five larvae with wing pads were at hand at one time.

Wing pads have been observed only in the fourth instar of the bean beetle. This instar consists of a motile larval phase and an attached quiescent or prepupal phase. The pads appear as two pairs of soft saclike evaginations of the dorsolateral walls of the mesothoracic and metathoracic segments. These turgid pads are of nearly equal size and shape and terminate in slightly pointed tips. The mesothoracic pads are covered with irregular fine brown setae not found on the

metathoracic pair. In some individuals collected the anterior pair of pads were dead and appeared as hard black knobs.

Several prothetelic larvae in the late fourth instar were observed sloughing the last larval cuticle prior to pupation (Fig. 2). The process was not completed and the individuals died. No cases were observed where larvae with wing pads passed successfully into the true pupal stage.

The wide seasonal and environmental ranges under which these unusual forms have been observed suggest that something other than environmental factors may be responsible for their appearance.

Geology of Puerto Rico.

The Geology of Puerto Rico is presented in 5 parts plus Conclusions, Bibliography, Glossary, and Index. In Part I the "Geologic Background" is presented in which the relation to the neighboring islands is set forth. Part II is "Geologic History" in which the actual known geology is depicted from the time of the volcanic core to the present form of the Island. The geologic column shows considerable volcanic rocks of upper Cretaceous age or older. Associated with these are shales and calcareous deposits, both often with much tuff. The Tertiaries are clastics and limestones of both the reef and shell types. The Quaternary is generally unconsolidated recent material. Part III entitled "Geologic Materials" is not petrography but a geologic discussion of the rocks, their structures, natural resources and the soils. In Part IV the "Geologic Present" deals with the physiography and the earthquake factors in the Island. Part V presents rather clearly the numerous questions to which answers are not known as yet relative to the geology of the region.

To briefly sum up the author's conclusions: On a shield of very ancient rock there was much volcanic activity with the regions between the volcanoes inundated by the sea. Later this volcanic-marine series was folded into mountains with accompanying intrusions of igneous rock. This mass was eroded to form the complex core. On the margins of this core were formed limestones and clastic deposits as the mass slowly sank. Then came a long series of uplifts so that the latter history is one of fluvial planation and uplift, the last uplift developing the rifts which set off the Island so abruptly. Now we have erosion working on a still unstable, tilted block.

To one interested in the Geology of the region this is a gold-mine of information. It is unfortunate that the author does not include fossil lists which are available. We hope that a latter Monograph will include them, to make the Series complete. This omission does not deduct from the value of the work. The author has spent enough time in the region to be familiar with the broader aspects of the geology and the details of numerous small areas and has made good use of the literature on the subject. Both Dr. Meyerhoff and the University of Puerto Rico are to be congratulated and we hope this new series of Monographs will all live up to the first one.—Willard Berry.

Geology of Puerto Rico, by H. A. Meyerhoff. 306 pp. Univ. of Puerto Rico Monograph No. 1, series B. 1933.

DEVELOPMENT AND DIFFERENTIATION OF TISSUES IN THE STEM TIPS OF GRASSES.

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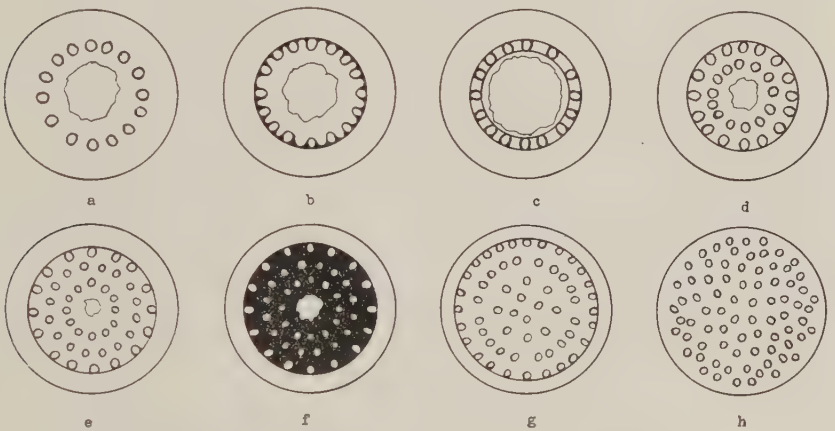
INTRODUCTION.

The study of the anatomy of the vegetative organs of the grasses has been confined to the examination of the mature structures. The internal anatomy of the leaves has been studied by Duval-Jouve (10), Pee-Laby (15), Lewton-Brain (16), Schwendener (19), Arber (2), Guntz (12), Holm (13), and others with special reference to differences that show means of identification of species, and with reference also to the types of structure in relation to the various habitats (14, 16, 18, 24). The work on the stem structure of the Gramineae is confined mainly to a record of the occurence of amphivasal bundles and to the theory of cambial activity in relation to the phylogeny of the group as stated by Van Teighem (23), Guillard (11), Crysler (8), and Holm (13).

The grasses have been described as hollow stemmed plants with scattered vascular bundles; and neither statement is definitive. Many of the grasses have solid stems, especially when grown in xerophytic situations; many of them do not have scattered vascular bundles, but have the bundles (Text Fig. 1, a, b, c) arranged in a circle between a central pith and an outer cortex (22). Many of the Festuceae and the Hordeae (Text Fig. 1, b) have a single circle of vascular bundles, while in the Agrostideae and Paniceae there are from one to three cycles of bundles (Text Fig. 1, d, e, f) in addition to the set in contact with the pericycle. Some of the Paniceae and all of the Andropogoneae have three or four cycles if vascular bundles (Text Fig. 1, e, f, g) in addition to those in contact with the pericycle, and the Tripsaceae (or Maydeae) have the vascular bundles in the scattered arrangement (Text Fig. 1, h). Some of the genera of the tribes present exceptions, but the general tendency is from vascular bundles in one circle to the arrangement scattered throughout the pith.

Most of the hollow stemmed grasses are those with only one or two cycles of vascular bundles around a large pith, and

most of the solid stemmed species are those with the scattered bundles or those with three or more cycles and a small pith. The first group is solid stemmed only when in slow-growing situations; the corn type is solid stemmed in any situation, and the Paniceae type of small pith is solid in xerophytic habitats. Canfield (6) reports that in the Jornada region of the southwest the hollow stemmed grasses are those that grow in more favored situations as to water supply and most of those that he reports as solid are members of the tribes that

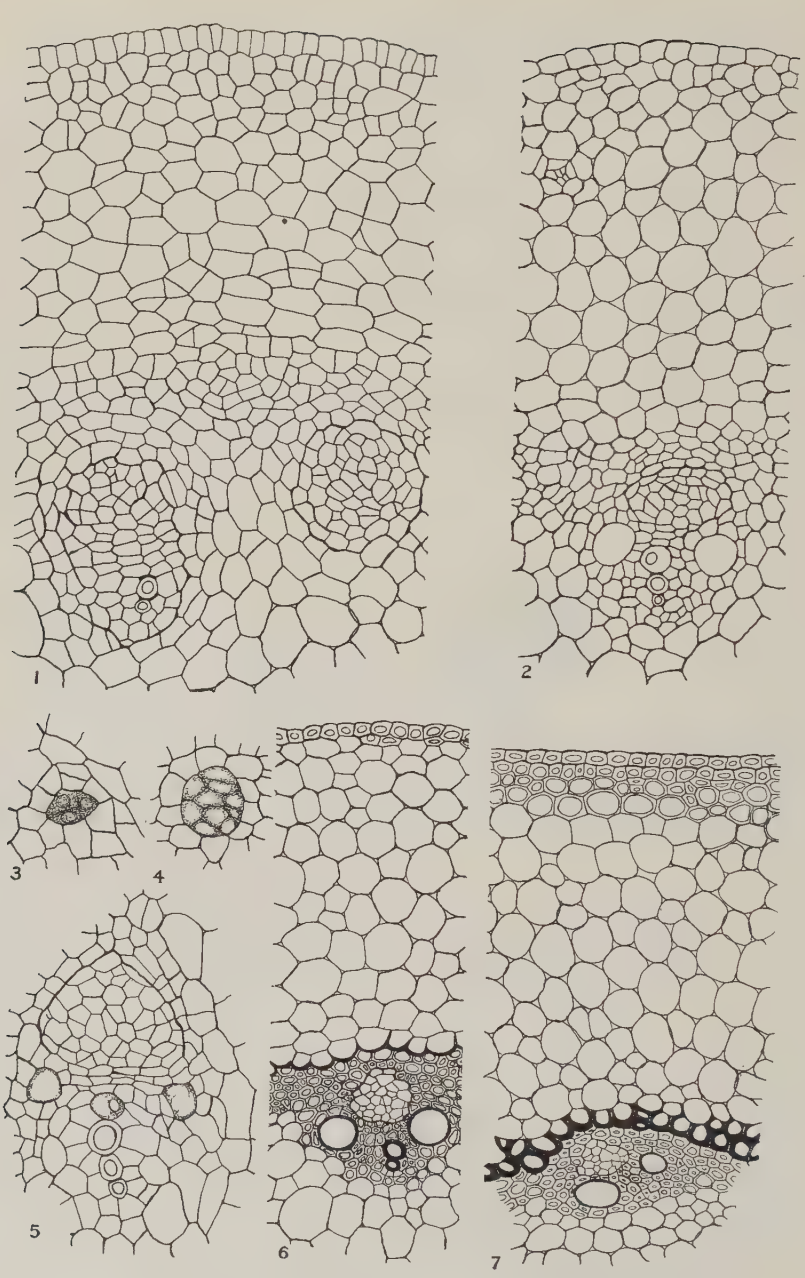


Text Fig. 1. Diagrammatic cross-sections of grass stems showing the arrangement of the vascular bundles of the stele. a, Leerzia; b, Agropyron; c, Phragmites; d, Eragrostis and Phleum; e, Aristida and Setaria; f, Panicum; g, Andropogon; h, Zea.

have the several cycles of bundles and small pith or those without pith and with scattered vascular bundles.

Duval-Jouve (10) states that the presence of a cortex and stele is the only thing about the stems that is common to all grasses. In the more primitive grasses the cortex is much thicker in proportion to the diameter of the stele than in the higher forms. The presence of a definite stelar pericycle in most of the tribes marks the limit of the stele and cortex, while in such genera as Sorghum and Zea the lack of a thickened pericycle fails to delimit these areas in the mature stem. The stem tips of Zea, however, do show a cortex.

This paper presents a study of the development and differentiation of tissues in four species of grasses whose mature structures show marked differences in the arrangement of the vascular strands. Serial sections through several nodes of the



FIGS. 1 TO 7, *Agropyron repens* (L.) Beauv.

stem tip were studied, and the arrangement and differentiation of vascular bundles of these were compared with the internodes of the mature stem, sectioned just below the node in the region where greatest lignification occurs, and also just above the node where the cells retain their meristematic activity longer. Sections of the rhizome and aerial stems of short and elongated internodes have been examined and found to show interesting relationships in structure, especially as to the character of the vascular bundles and the stelar and bundle pericycle.

The arrangement of vascular strands in grasses is of various types (22), but those chosen for this study are: (a) vascular bundles in a single circle as shown by *Agropyron*, (b) vascular bundles in two to five circles as in *Spartina* and *Calamovilfa*, and (c) vascular bundles scattered as in *Zea*. The first two always have a central pith although they may be hollow in maturity. This arrangement of bundles in a single circle has been shown by Holm (13) and by Duval-Jouve (10). The variations from the arrangement of bundles seen in *Agropyron* to the extreme scattered type in *Zea* seem to show a definite trend of vascular evolution with the scattered bundles as the highest type in the series.

Description.

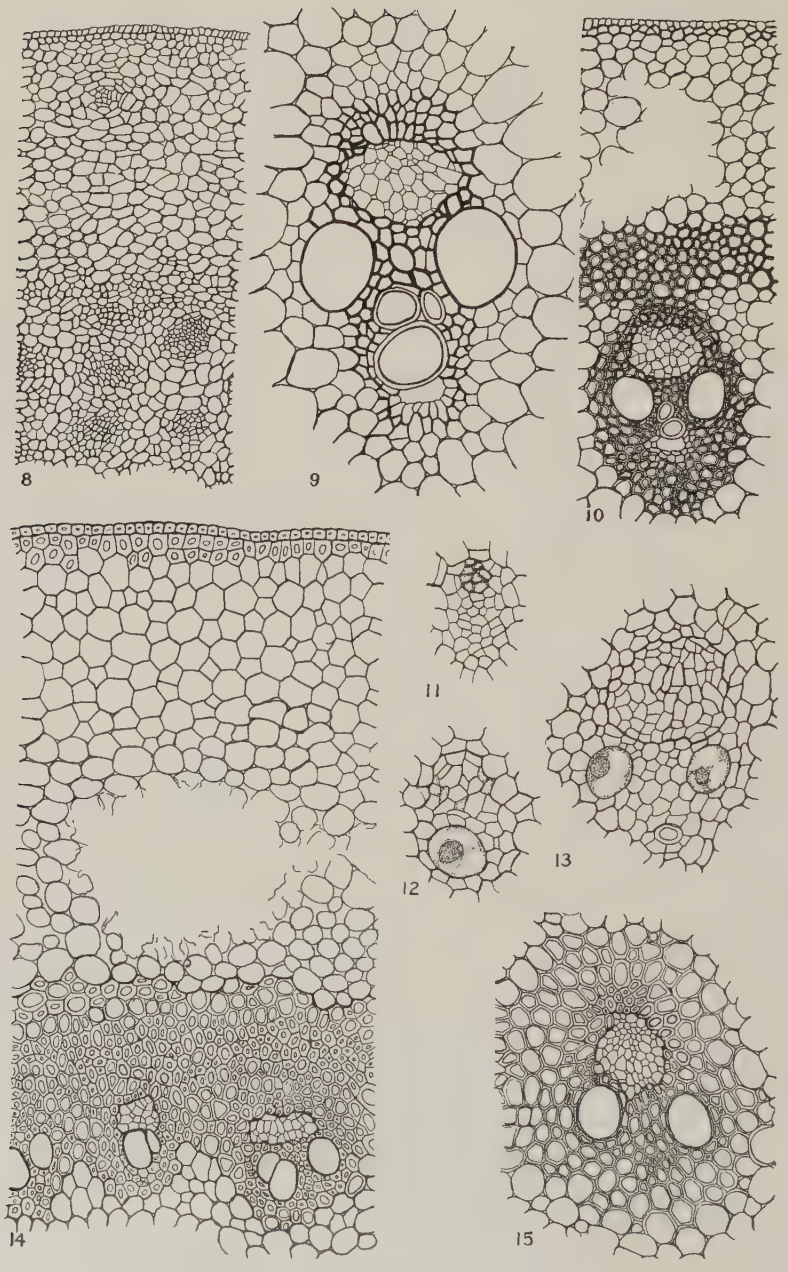
Agropyron repens (L.) Beauv.

(Plate I)

The vascular strands of this grass arise in the stem tip in a circle that marks off a definite cortex and pith (Figs. 1, 2). No vascular strands are formed in the pith and those found in the cortex are leaf traces. Thus the arrangement in the meristem is the same as in the mature stem. The form of the mature bundle, however, varies as to the number of protoxylem vessels according to the degree of elongation (Figs. 5, 6, 7). The youngest bundle strand is recognized by the denser cytoplasm of two or three cells (Fig. 3). These rapidly divide until a cross section of the bundle shows from 25 to 30 cells (Fig. 1). This is

Explanation of Plate I.

Fig. 1. Cross-section of young stem tip showing two young bundles of the circle.
Fig. 2. Older stage of the same stem tip.
Figs. 3 and 4. Cross-section of young bundles.
Fig. 5. Bundle from rapidly growing region showing cambium-like cells caused by pressure of xylem and phloem.
Fig. 6. Portion of rhizome of longer internode near surface of ground showing two protoxylem vessels and lignified endodermis and pericycle.
Fig. 7. Portion of rhizome showing heavy endodermis and vascular bundle without protoxylem. Epidermis and hypodermis are thick-walled and lignified.



FIGS 8 TO 15, *Spartina michauxiana* Hitchc.

followed by a general enlargement and division of the whole strand until the first protoxylem vessels are formed (Fig. 1), and then the cells of the phloem region continue to divide and enlarge so that they appear as a definite area of the bundle (Fig. 1). In the slow-growing internode only one or two small protoxylem vessels are formed, sometimes none at all (Figs. 6, 7); for example, in the rhizome the phloem is differentiated first and only one to three metaxylem vessels are formed (Fig. 7). In the aerial stem of long internodes from two to five protoxylem vessels are developed (Figs. 5, 6).

In the rhizome there is a pronounced endodermis and a pericycle (Fig. 7) which is of thick-walled lignified cells and almost surrounds the vascular strands that in turn become wholly lignified except for the phloem (Fig. 7). The cortex develops small air passages, and the epidermis and hypodermal layers become lignified. In this same stem the pericycle and endodermis gradually diminish as the culm becomes aerial and in some forms entirely disappaer in the above-ground parts.

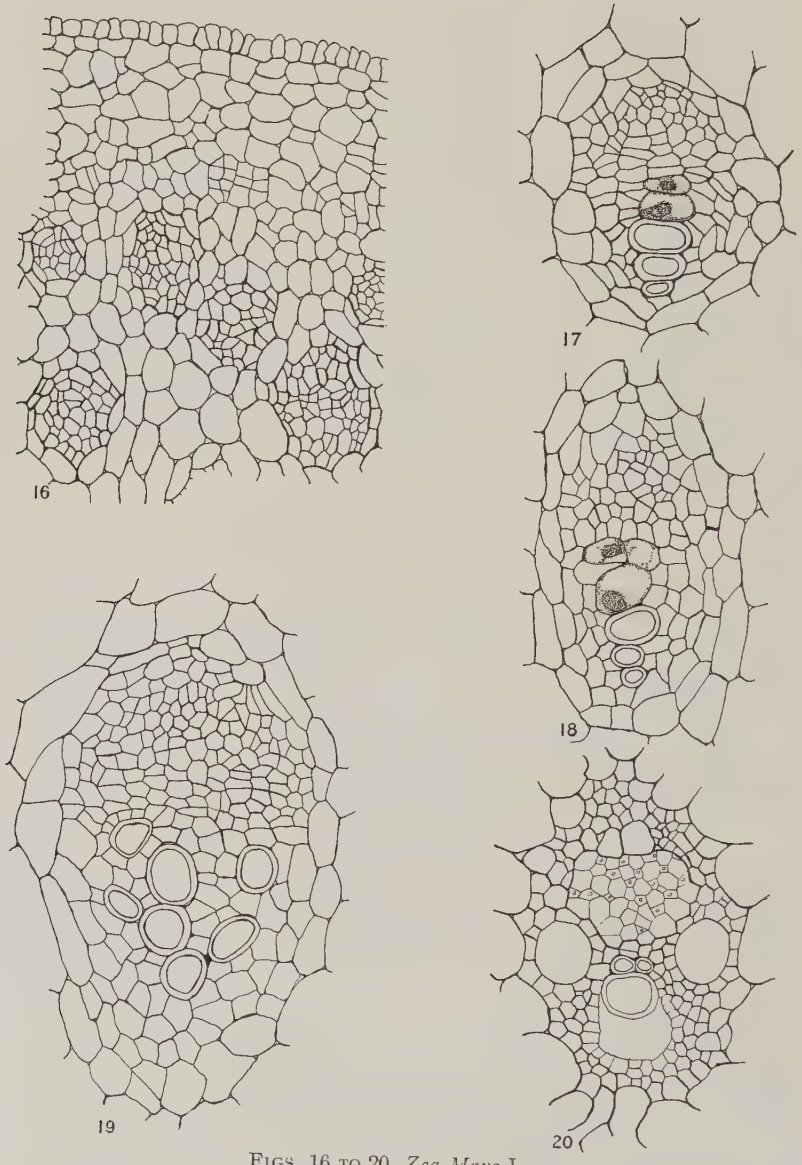
Spartina michauxiana Hitchc.

(Plate II)

In *Spartina* the vascular strands arise in a band of two or three circles with a definite cortex (Fig. 8). The bundles first appear as they do in the other forms, but the metaxylem vessels are the first water tubes to appear (Fig. 12). The sieve tubes and their companion cells form at approximately the same time. Similarly in the rhizome and slow-growing internodes of the aerial stem no protoxylem vessels are found, but in the elongated internodes of the aerial part there may be two or more (Figs. 9, 10). In the rhizome the outer circle of vascular bundles is imbedded in the lignified pericycle which is surrounded by an endodermis (Fig. 14). The inner circles are not connected to the pericycle except for an occasional bundle. This structure is in contrast to the aerial stem of *Spartina* where the endodermis and pericycle appear only in fragments. In both rhizome and aerial stems the epidermis and hypodermal layers become thick-walled and lignified, and in both the cortex enlarges and there appear numerous lysigenous air passages (Fig. 14).

Explanation of Plate II

Fig. 8. Portion of young stem tip showing young vascular bundles and cortex.
Fig. 9. Inner vascular bundle of the aerial stem.
Fig. 10. Portion of aerial stem showing cortex with air passages, and one of the outer circle of vascular bundles attached to a fragment of the pericycle.
Fig. 11. Young bundle showing beginning of phloem before any xylem tubes appear.
Fig. 12. Young bundle showing phloem with companion cells and a single metaxylem vessel.
Fig. 13. Cross-section of bundle showing a single spiral vessel which was formed after the metaxylem vessels were enlarged.
Fig. 14. Portion of cross-section of mature rhizome.
Fig. 15. A single vascular bundle of a short internode of rhizome without spiral vessels, all of the cells lignified except phloem.



FIGS. 16 TO 20, *Zea Mays* L.

Fig. 16. Portion of cross-section of young stem tip.
Fig. 17. Immature bundle of young plant with five spiral vessels and no metaxylem, and with cells pressed into cambium-like shapes.
Fig. 18. Immature bundle from same region as Fig. 17 with lateral pressure showing complete lack of cambium-like cells.
Fig. 19. Vascular bundle from young rapidly growing plant with seven protoxylem vessels and no metaxylem vessels.
Fig. 20. Immature vascular bundle of normal type, no indication of cambium.

Calamovilfa longifolia (Hook.) Hack.

The stem structure of *Calamovilfa* (Text Fig. 1) is similar to that of *Spartina* except that in the mature rhizome all the vascular portion of the stele becomes very thick-walled and even the phloem cells become lignified. The vascular bundle originates from a single cell and develops as in *Agropyron* with protoxylem vessels only in the bundles of the longer internodes. In this highly lignified stem some of the bundles in the nodes and short internodes are amphivasal. In the aerial stem there is evident cortex, and a pith that finally breaks down in the center so that the stem has a small cavity.

Zea Mays.

(Plate III)

In the stem tip of corn the vascular strands develop at some distance from the epidermis and mark off a cortex (Fig. 16). This apparently disappears because there is no development of pericycle and endodermis, and therefore with the abundant leaf traces the mature stems have numerous scattered bundles without a definite marking to show the limits of the stele and cortex.

The vascular strands evidently begin with two or more cells, and the protoxylem vessels are the first cells of the bundle to be differentiated. In the rapidly growing young plants of the laboratory where there is little lignification the number of protoxylem vessels is larger than in any other form examined (Figs. 17, 18, 19), and in these bundles no metaxylem vessels are developed. This is a variation from normally grown plants where the vascular bundle develops as in *Agropyron* and *Calamovilfa* (Figs. 16, 20). As in the other grasses lignification in aerial stems is greatest just below the node. In the short internodes the bundles do not have lacunae, although practically all the strands of the average length of internode have lacunae by reason of the destruction of the protoxylem vessels by rapid elongation after their lignification (Fig. 20).

CAMBIAL ACTIVITY.

Crysler (8), Van Teighem (23), Guillard (11), and Andersson (1) have reported and figured a temporary cambium in several grasses. One does not find in their studies any figure of mitotic phases in these cells; and evidently all the figures were taken from either mature or nearly mature aerial stems, or from the meristematice region of the lower part of the internode. The present study has not revealed any cell division in the area between xylem and phloem after these areas are differentiated except for occasional cells. Cells divisions do occur in the xylem and phloem areas of the vascular strand and not in the cells between them where the cambium would originate. The number of cells that occur on a line from the

inner portion of the phloem to the innermost cell of the xylem is within one or two cells of being a constant number, regardless of the size of the bundle. Apparently this number does not change after the xylem vessels begin to be lignified. The explanation of the appearance of cambial cells—and this is very striking—is that the rapid enlargement of the phloem and xylem presses the intervening cells into the shape of cambium cells (Figs. 1, 2, 5, 17). In those bundles where the pressure is lateral, although several protoxylem vessels are formed, no semblance of cambium appears (Figs. 18, 19).

The meristematic condition of all cells of the vascular bundle in growing regions is evident from the continued differentiation of protoxylem vessels in such bundles (Figs. 17, 18, 19). The appearance of a cambial arrangement of cells in a relatively small number of bundles and its absence in other bundles of the same size in the same meristematic area, (Figs. 18, 19), the absence of observed mitosis, and the constancy of number of cells mentioned above, all seem to demonstrate that there is not even a temporary cambium in the grass bundle (Fig. 21).

DISCUSSION.

If a complete study of the comparative anatomy of the grass tribes is made it now seems possible to the writer that some of the questions regarding the position of the tribes in a developmental series may be solved. The scattered vascular bundle type is certainly the top of the series, as it is now placed, and the writer believes that the single circle of bundles between cortex and pith is the lowest form of the series (22). The relationship of genera and their proper places within the tribes may be made clear also by the study of the vascular anatomy. The question of species must take into account the effect of environment of stem structures, since the development of tissues shows such definite variations in response to the rates of growth (Figs. 5, 6, 7, 10, 14, 18, 19, 20). The cortex, endodermis, and pericycle vary in amount and degree of lignification depending not only on the inherited type of bundle arrangement in the series pointed out but also on the rate of growth. The marked differences in the development of the xylem strands is directly related to the rate of growth, and there seems to be very little variation in the stucturre of the individual bundle phylogenetically except as to the amount and character of the bundle pericycle.

Various authors have figured and labeled a proto-phloem as distinct from the mature phloem. It is evident from the figures shown in this paper that there is no such distinction. The xylem and phloem develop by cell divisions in the inner and outer portions of the vascular bundles and there is no further development after their differentiation except the thickening and lignification of the cell walls of the water tubes and bundle pericycle.

SUMMARY.

1. All the stem tips of the grasses studied show a stele and a cortex even though they are not delimited in the mature stem.

2. The vascular bundles of the grasses are not all arranged as in *Zea*, for the arrangement varies from a single circle through a series of forms to the scattered vascular bundle type.

3. The hollow stem or solid stem in the grasses depends first upon the arrangement and number of the vascular bundles and second upon the rate of growth.

4. There is a tendency for both the stelar and bundle pericycle to become less pronounced as the scattered vascular bundle type is approached.

5. In the vascular bundles:

a The number of the protoxylem vessels varies with the amount of elongation and the duration of the meristematic condition.

b There is no distinction of proto-phloem and meta-phloem.

c There is no temporary cambium.

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Invertebrate Zoology.

This, the most recent of the many zoological textbooks written by the author, is stated to be a revision and expansion of his first, the Introduction to Zoology, published in 1910. It is well planned and organized, and in the same general style as his previous books. The classification is, on the whole, conservative. Short, but comprehensive descriptions of representative types are given, in which both structural and functional aspects are stressed. Illustrations are numerous, and for the most part clear and well selected, although there are a few serious omissions and some poor selections. The only strictly original illustrations are the eight excellent full-page stereograms by Mrs. Root.

Careful examination and several months' use as a textbook in the reviewer's classes have disclosed a number of defects. Typographical errors are far too frequent for a book of this character. Drawings borrowed from other authors have usually been redrawn and relabeled; and while the redrawing has been good, the relabeling has in several cases been careless and confused. (For example, figures 71, 252, 254, 256.) The life history of Gonionemus is not given as fully as it might have been; the author does not seem to be familiar with Joseph's 1925 paper on this subject. In the chapter on Mollusca there is no discussion of the lamellibranch gill as a feeding mechanism, and no adequate description of its structure or its ciliation.

Similar omissions may be noted in other chapters also. The discussions of the comparative anatomy and phylogeny of the invertebrates seem inadequate for an advanced textbook of invertebrate zoology.—W. J. Kostir.

Invertebrate Zoology, by Robert W. Hegner. xiii + 570 pp. New York, The Macmillan Co., 1933.

A NEW SPECIES OF TYPHLOCYBA (HOMOPTERA CICADELLIDAE) INJURIOUS TO PRUNE IN THE PACIFIC NORTHWEST.

D. M. DeLONG AND RALPH H. DAVIDSON,
Ohio State University, Columbus, Ohio.

Typhlocyba pruni n. sp.

Resembling *T. pomaria* McA. in form and general appearance and apparently previously confused with it. But with a brighter yellow appearance, head more bluntly and broadly rounded and male genital character distinct. Length 7 mm.

Vertex bluntly broadly rounded, strongly curved in front.

Color: Male, pale yellow, wings bright yellow for two-thirds their length, apical third smoky; female, milky white usually without yellow markings.

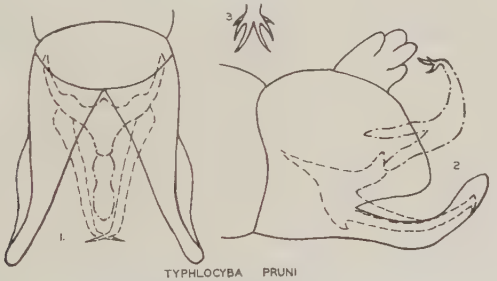

FIG. 1. Ventral view of male genitalia in position.
FIG. 2. Lateral view of male genitalia in position.
FIG. 3. Dorsal view of apex of oedagus (enlarged), showing arrangement of spines.

Genitalia: Female, last ventral segment roundingly produced, male, valve short, broad, transverse, slightly emarginate at middle. Plates broad at base, abruptly narrowed at about one-third their length and produced in rather long narrow tips which are upturned and slightly divergent. Styles long and narrow. Apices turned inward and sharp pointed, the long tips overlapping when in natural position. Oedagus directed upward and anteriorly at the apex, the apical portion composed of two branched and two unbranched spines. The inner two are unbranched and are longer than the outer two which are branched. From the dorsal view the two inner

spines are divergent toward the tip while the dorsal portion of the outer spines curve slightly inwardly. From the lateral view the lower fork of the outer spine can be seen projecting ventrally.

Described from a series of specimens collected at Parma, Idaho, and Opportunity, Washington. The senior author collected specimens at Parma in the summer of 1930, while collecting in the field with Mr. Haegele and a large series has been recently forwarded from both localities by Mr. R. W. Haegele of the Parma Station. These were collected in July and September and were all taken from cultivated prune.

Holotype male and allotype female from Parma, Idaho.

The Theory of Embryological Development.

Part I is a translation and condensation of **Theoretische Biologie,** 1932, while Part II, the major part of the work, is a translation of "Kritische Theorie der Formbildung," 1928. In Part I, von Bertalanffy points out that the present method of biological thought is not on the high plane of that in physics, mathematics, and astronomy, where theory after theory is boldly proposed to be superseded by one better when the preceding can be shown to be inapplicable. He believes that leaders in biology do not theorize enough. In a way von Bertalanffy is right. Baffled by the complexity of problems the average biologist hesitates to formulate theories. Unfortunately in many minds this attitude has become almost a doctrine which creates a depressing atmosphere in which to work.

Part II is a review and searching critique of the recently proposed explanations of embryological development and regeneration. The mechanistic theories are shown to be weak because they explain development as an arithmetical increase in complexity, an additive process. The vitalistic theories fail because they include a transcendent entelechy, an immaterial principle that cannot be demonstrated. "Neither of these views is justified by the facts. . . . The solution is to be sought in an **organismic** or **system** theory of the organism which, on the one hand, in opposition to the machine theory, sees the essence of the organism in the harmony and co-ordination of the processes among one another, but, on the other hand, does not interpret this co-ordination as vitalism does, . . . but through the forces imminent in the living system itself." The theory will have to consider the developing organism, (1) as a physico-chemical system, (2) in its intricate organization, and (3) as an end product of its evolutional history.

The author admits the difficulty of outlining such a master theory, but points out some features that will have to be included: It must (1) be a law of biological maintenance, "the organic system tends to preserve itself." It exists as a pseudo-equilibrium (Przebram's bio-dynamic equilibrium) as it is capable of doing work. (2) The organization indicates an heirarchial order of parts and forces (Child's metabolic gradients). From this there is a tendency towards maximal organization. Among the organizing forces are the "field laws" of Weiss and the geometrical conceptions of Gurwitsch.

The only criticism beyond that of the involved German style is that half of the animal species are recessive in evolution and to some extent recessive in later stages of ontogeny. These are the parasites and others that settle down to a food supply continuous in space in consequence of which they become less complex in their loss of locomotor organs and sense organs. The ontogeny of the tunicates is a good example.—C. H. K.

Modern Theories of Development; An Introduction to Theoretical Biology, by Ludwig von Bertalanffy. (Translated and adapted by J. H. Woodger.) Pages i-x and 1-204. New York, Oxford University Press, 1934. $3.00.

ADDITIONS TO THE OHIO LIST OF ROBBER FLIES. II. (DIPTERA:ASILIDAE)

STANLEY W. BROMLEY.

There were 65 species of Asilidae recorded from Ohio in my "Preliminary List of the Robber Flies of Ohio" (Ohio State Museum Science Bulletin, Vol. I, No. 2, November 1, 1931). During the season of 1932 and 1931, five species were added, bringing the total to 70 (Ohio Journal of Science, Vol. XXXIII, No. 3, May, 1933, p. 204). During the summer of 1933, Mr. E. S. Thomas, Curator of Natural History of the Ohio State Museum, and Mr. Charles F. Walker, Assistant Curator, continued their active collecting, with the result that the Ohio Asilid material in the Museum of four years ago has been increased about five-fold. Some very interesting records have been obtained. Among them were two additional records for the state.

71. *Atmosia rufipes* Macquart. McArthur, Ohio, July 11, 1933 (E. S. Thomas).
72. *Asilus piceus* Hine. Holland, Lucas County, August 11–13, 1933 (E. S. Thomas). A rare species hitherto recorded only from New England.

Other records of interest were two specimens of *Lampria bicolor* (Wiedemann) taken by E. S. Thomas at "Neotoma," Hocking County, July 3–4, 1933; two specimens of *Leptogaster brevicornis* Loew taken at the same locality, July 3–9, 1933; a series of six *Proctacanthus milbertii* Macquart, Holland, Lucas County, August 11–13, 1933 (L. W. Campbell, R. Conant, and E. S. Thomas); and a specimen of *Promachus hinei* Bromley taken in Salem, Champaign County, July 27, 1933, by Charles F. Walker.

Most interesting of all was the capture by Mr. Charles F. Walker at the State Game Farm, Salem, Champaign County, of two specimens of the extremely rare *Dasylechia atrox* Williston; one on August 2, and one on August 29, 1933. I am quoting Mr. Walker's observations on this remarkable insect. "In both instances, the flies first attracted attention by their loud droning flight as they circled about my head. In one

case, we were working around a new wooden shed, and my first thought was that the insect was a carpenter bee attracted by this fresh wood. Their appearance was very suggestive indeed of these bees until they came to rest, in one case on an electric line; in the other, on a chicken-wire cover to a partridge pen. They were unsuspicuous and sluggish, in one case easily allowing capture by hand, and the other—the one on the electric wire out of reach—was easily secured with a net. The location was an open pastured oak-hickory-maple woodland on a gravelly moraine." Both were males. This makes the fourth Ohio record of this species (all from the Western part of the state). There are scarcely more than a dozen records of this species.

This calls to mind an account of the capture of one of these rare flies, related to me by the late C. W. Johnson, Curator of Insects of the Boston Society of Natural History. In this case, the fly persistently flew about the head of a pedestrian in a city park of Philadelphia, Pa., until it was captured.

Mr. H. J. Reinhard, Entomologist of the Texas Agricultural Experiment Station, during July collected extensively at Amherst, Lorain Co., Ohio, securing among a large series of Leptogasters, two species hitherto unrecorded from the state. These additions bring the Ohio Asilid list to 74 species.

73. *Leptogaster atridorsalis* Back. Amherst, July, 1933 (H. J. Reinhard).
74. *Leptogaster* (*Psilonyx*) *annulatus* Say. Amherst, July, 1933 (H. J. Reinhard).

Historical Geology.

This text departs from the time honored system of period by period discussion of Geologic history. It is divided into two major parts; the first 80 pages taking up the "Principles of Stratigraphy" and the remainder of the book concerning "Geologic Provinces." Under the caption "Geologic Provinces" are considered the following localities: the Grand Canyon Region, Niagara Falls, the Appalachians, the Northwest Highlands of Scotland, the Alps, and Yellowstone Park and the Big Horn Basin Region. The plates are either uncolored geologic maps or block diagrams of the regions discussed. The figures which are line cuts include numerous small maps illustrating various stages in the geologic history of the regions concerned. The reviewer is not as yet prepared to say whether he is in favor of this new manner of presentation of Historical Geology, although he admits that the old manner of presentation is far from perfect. The question arises, is it preferred to give the student the complete history of a Continent or is it better to explain the local history of selected parts? Certainly from the latter standpoint this text is excellent. We would be inclined to say that it is the type of text for the passing student and not so much for the student who is mainly interested in advanced Geology.—WILLARD BERRY.

The Principles of Historical Geology from the Regional Point of View, by Richard M. Field. xii+284 pp. Princeton, the University Press, 1933.

ADDITIONS TO THE REVISED CATALOG OF OHIO VASCULAR PLANTS. II*

JOHN H. SCHAFFNER.

There appears to be no abatement of the interest in the Ohio flora, aroused by the publication of the Revised Catalog in 1932, as is evident from the list of additions presented below. This list represents but a small percent of the records showing decided extensions of the geographic ranges of our Ohio species. In the first list of Additions to the Catalog, 41 species new to the state were published; in the present list, 34 new Ohio species are added, bringing the total number of species cataloged for Ohio up to 2,384. Among the many interesting discoveries are several species originally published by Bigelow, in 1841, as occurring in Fairfield County but not known to have been seen since that time. A report on the status of some of the Ohio species of Phlox by Edgar T. Wherry of Philadelphia, a specialist in this difficult group, is included in its proper place below, and it is hoped that collectors will make special efforts to send in specimens of the rarer species that we may soon have a more reliable list. During the year about 4,000 specimens have been mounted, labeled, and distributed in the State. Herbarium. The Herbarium is still greatly hampered by a lack of suitable cases to hold this valuable collection properly, and it is hoped that this difficulty may be overcome in due time, when more favorable financial conditions return. Ohio is certainly rich enough to develop one good herbarium. There should be a number of such institutions in the state.

1. *Ophioglossum vulgatum* L. Adder-tongue. Indian Springs ravine, Columbus, Franklin Co. Mrs. M. S. Humphrey.
2. *Botrychium simplex* Hitch. Little Grape-fern. Farnham, Ashtabula Co. L. E. Hicks.
3. *Botrychium neglectum* Wood. Wood's Grape-fern. Indian Springs ravine, Columbus, Franklin Co. L. E. Hicks.

19. *Pellaea glabella* Mett. Northern Purple Cliff-brake. "On perpendicular face of slightly shaded low limestone cliffs." North-west of Locust Grove, Adams Co. Arthur N. Leeds.

41. *Dryopteris dilatata* (Hoffm.) Gr. Spreading Shield-fern. Near Beach City, Sugar Creek Twp., Stark Co. W. H. Camp.

53. *Equisetum laevigatum* A. Br. Smooth Scouring-rush. Mentor Marsh, Lake Co. L. E. Hicks.

*Papers from the Department of Botany, the Ohio State University, No. 338.

55. *Equisetum kansanum* Schaffn. Kansas Scouring-rush. Conneaut R. Ashtabula Co. L. E. Hicks.
66.1. *Lycopodium tristachyum* Pursh. Slender Trailing Club-moss. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius. Also old misnamed specimens from Licking (R. F. Griggs), Fairfield (E. V. Wilcox.), and Hocking (R. F. Griggs) counties.
67. *Lycopodium complanatum* L. Trailing Clubmoss. The var. flabelliforme Fern. Near Beach City, Sugar Creek Twp., Stark Co. W. H. Camp.
69. *Selaginella apoda* (L.) Fern. Creeping Selaginella. Serpent Mound, Adams Co. Edw. S. Thomas.
78. *Juniperus communis* L. Common Juniper. Parkman Twp., Geauga Co. Charles Dambrach.
78a. *Juniperus communis depressa* Pursh. Parkman, Geauga Co. L. E. Hicks, C. Dambach, and F. B. Chapman.
90. *Scheuchzeria palustris* L. Scheuchzeria. Lake Twp., Ashland Co. Leslie L. Pontius and Floyd Bartley.
101. *Potamogeton perfoliatus* L. Clasping-leaf Pondweed. Tuscarawas River, Fayette Twp., Coshocton Co. Frank B. Selby; Ashtabula Beach, Ashtabula Co. L. E. Hicks.
108. *Potamogeton dimorphus* Raf. Spiral Pondweed. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.
111.1. *Naias marina* L. Large Naias. Lake Cardinal, Ashtabula Co. L. E. Hicks.
114. *Brasenia schreberi* Gmel. Water-shield. Mouth of Conneaut River, Ashtabula Co. L. E. Hicks.
114.1. *Cabomba caroliniana* Gr. Cabomba. Abundant in Mosquito Creek. Escaped. From the South. Howland Twp., Trumbull Co. Almon N. Rood.
115. *Nelumbo lutea* (Willd.) Pers. American Water-lotus. Jerusalem Twp., Lucas Co. Louis W. Campbell.
117. *Castalia odorata* (Dry.) W. & W. Sweet-scented Water-lily. Jerusalem Twp., Lucas Co. Louis W. Campbell.
118. *Castalia tuberosa* (Paine) Greene. Tuberous Water-lily. Silver Lake, Logan Co. E. Jane Spence. Sent in by Wm. C. Werner. Mouth of Conneaut River, Ashtabula Co. L. E. Hicks.
150. *Scirpus planifolius* Muhl. Flat-leaf Clubrush. Toledo, Lucas Co. J. A. Sanford (1878). Presented by Wm. C. Werner.
155. *Hemicarpha micrantha* (Vahl.) Pax. Common Hemicarpha. Geneva, Ashtabula Co. L. E. Hicks.
157. *Eleocharis acuminata* (Muhl.) Nees. Flat-stemmed Spike-rush. Swamp near Chillicothe, Ross. Co. F. B. Chapman.
160.1. *Eleocharis rostellata* Torr. Beaked Spike-rush. Cedar Swamp, Champaign Co. Edw. S. Thomas.
166. *Stenophyllus capillaris* (L.) Britt. Hair-like Stenophyllus. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.
169. *Cyperus retrofractus* (L.) Torr. Rough Cyperus. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.
173. *Cyperus engelmanni* Steud. Engelmann's Cyperus. E. Conneaut Beach, Ashtabula Co. L. E. Hicks.
177.1. *Cyperus acuminatus* Torr. & Hook. Short-pointed Cyperus. Green Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
187. *Mariscus mariscoides* (Muhl.) Ktz. Twig-rush. Cedar Swamp, Champaign Co. E. S. Thomas.
189. *Scleria triglomerata* Mx. Tall Nut-rush. Northwest of Amboy, Ashtabula Co. L. E. Hicks.
199. *Carex muhlenbergii* Schk. Muhlenberg's Sedge. Painesville, Lake Co. Wm. C. Werner. Wood Co. Albert Neifer.
202. *Carex laevenworthii* Dew. Leavenworth's Sedge. Phelps Creek, Ashtabula Co. L. E. Hicks.
209. *Carex annectens* Bickn. Yellow Fox Sedge. Red Hills region, Franklin Co. Floyd B. Chapman.
212. *Carex prairea* Dew. Prairie Sedge. Painesville, Lake Co. Wm. C. Werner.

216. *Carex crus-corvi* Shuttlw. Raven-foot Sedge. Wood Co. Albert Neifer. Sent in by Wm. C. Werner.
231. *Carex muskingumensis* Schw. Muskingum Sedge. Lower Grand River and Rock Creek, Ashtabula Co. L. E. Hicks.
233. *Carex stnaminea* Willd. Straw Sedge. Conneaut, Ashtabula Co. L. E. Hicks.
261. *Carex eburnea* Boott. Bristle-leaf Sedge. Paint Twp., Highland Co. Katie M. Roads.
274. *Carex striatula* Mx. Striate Sedge. Scioto Co. Floyd Bartley and Leslie L. Pontius.
280. *Carex conoidea* Schk. Field Sedge. Crystal Lake near New Carlisle, Clark Co. E. N. Transeau.
292. *Carex caroliniana* Schw. Carolina Sedge. Phelps Creek, Ashtabula Co. L. E. Hicks.
304. *Carex irregularis* Schw. Green Sedge. Marl bog at Kennard, Champain Co. Edw. S. Thomas.
305. *Carex cryptolepis* Mack. Small Yellow Sedge. Plymouth Marshes, Ashtabula Co. L. E. Hicks.
332. *Bromus inermis* Leyss. Hungarian Brome-grass. Saybrook, Ashtabula Co. L. E. Hicks. Near State Game Farm, Champaign Co. E. S. Thomas.
339. *Festuca shortii* Kunth. Short's Fescue-grass. Conneaut, Ashtabula Co. L. E. Hicks.
351. *Panicularia grandis* (Wats.) Nash. Tall Manna-grass. Conneaut, Ashtabula Co. L. E. Hicks.
357. *Poa de'ilis* Torr. Weak Spear-grass. Wayne Twp., Ashtabula Co. L. E. Hicks.
390. *Deschampsia caespitosa* (L.) Beauv. Tufted Hair-grass. Geneva-on-the-Lake marsh, Ashtabula Co. L. E. Hicks.
391. *Deschampsia flexuosa* (L.) Trin. Wavy Hair-grass. Mt. Pleasant, Lancaster, Fairfield Co. R. B. Gordon. Stows Corner, Summit Co. Floyd Bartley and Leslie L. Pontius.
409.1. *Cinna latifolia* (Trev.) Griseb. Broad-leaf Wood Reed-grass. Monroe Twp., Ashtabula Co. L. E. Hicks.
415.1. *Muhlenbergia capillaris* (Lam.) Trin. Long-awned Muhlenbergia. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.
430. *Aristida purpurascens* Poir. Purplish Tripple-awned-grass. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.
433a. *Phalaris arundinacea picta* L. Garden Ribbon-grass. Along railway track near New Vienna, Clinton Co. Along the road, Piketon, Pike Co. Katie M. Roads.
438. *Lolium multiflorum* Lam. Awned Darnel. Near Buchtel, Athens Co.; Circleville, Pickaway Co. Leslie L. Pontius and Floyd Bartley.
445. *Elymus hirsutiglumis* Scribn. Strict Wild-rye. Beach near Geneva-on-the-Lake, Ashtabula Co. L. E. Hicks.
446.1. *Elymus brachystachys* Scribn. & Ball. Short-spiked Wild-rye. Southeastern Wayne Twp., Ashtabula Co. L. E. Hicks.
456.1. *Dactyloctenium aegyptium* (L.) Willd. Egyptian-grass. Ashtabula Harbor, Ashtabula Co. L. E. Hicks.
491. *Panicum villosissimum* Nash. Villous Panic-grass. Conneaut, Ashtabula Co. L. E. Hicks.
493. *Pancium meridionale* Ashe. Matting Panic-grass. Crystal Lake near New Carlisle, Clark Co. E. N. Transeau.
505.1. *Echinochloa colona* (L.) Link. Jungle-rice. Persistent and spontaneous after cultivation. From the South. Dorset, Ashtabula Co. L. E. Hicks.
508. *Paspalum setaceum* Mx. Slender Paspalum. Pickaway Twp., Pickaway Co.; Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.
514.1. *Holcus sudanensis* Bailey. Sudan-grass. Escaped from cultivation. Native of Africa. Painesville, Lake Co. Wm. C. Werner.
517. *Miscanthus sinensis* Andress. Chinese Plume-grass. Sunfish Creek, Pike Co. M. B. Trautman.
543. *Scilla sibirica* Andr. Siberian Squill. Along the road in Liberty Twp., Highland Co. Katie M. Roads.

547. *Aletris farinosa* L. Colic-root. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.
549. *Veratrum viride* Ait. American False-hellebore. Perry Twp., Tuscarawas Co. Irma Nelson.
575. *Clintonia umbellulata* (Mx.) Torr. White Clintonia. White's Gulch, Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.
596. *Juncus dudleyi* Wieg. Dudley's Rush. Crystal Lake, near New Carlisle, Clark Co. E. N. Transeau.
611. *Juncoides carolinae* (Wats.) Ktz. Hairy Wood-rush. Phelps Creek, Ashtabula Co. L. E. Hicks, F. B. Chapman, and C. Dambach.
613. *Juncoides bulbosum* (Wood) Small. Bulb-bearing wood-rush. In a damp woods near Henley, Scioto Co. Katie M. Roads.
624.1. *Sisyrinchium strictum* Bickn. Strict Blue-eyed-grass. In wet field. Higby Prairie, Franklin Twp., Ross Co. F. B. Chapman and L. E. Hicks.
629. *Iris foliosa* Mack. & Bush. Leafy Blue-flag. Green Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
632.1. *Iris verna* L. Spring Dwarf Iris. Nile Twp., Scioto Co. Conrad Roth. Brush Creek Twp., Scioto Co. A. E. Waller, Geo. Schoedinger, and Robert McCormick.
636. *Cypripedium candidum* Willd. White Lady's-slipper. Reported as growing in a damp swamp in Portage Co. by Almon N. Rood.
657. *Ibidium praecox* (Walt.) House. Grass-leaf Lady's-tresses. Fredericktown, Columbiana Co. E. S. Thomas.
659. *Ibidium beckii* (Lindl.) House. Little Lady's-tresses. Mouth of Moxahala Creek, Muskingum Co. E. S. Thomas.
659.1. *Ophrys cordata* L. Heart-leaf Twayblade. E. Monroe Twp., Ashtabula Co. Lawrence E. Hicks, and Floyd B. Chapman.
662. *Arethusa bulbosa* L. Arethusa. Reported as occurring in a swamp in Portage Co. by Almon N. Rood.
669. *Tipularia unifolia* (Muhl.) B.S.P. Crane-fly Orchis. "Neotoma," Goodhope Twp., Hocking Co. Edw. S. Thomas. Benton Twp., Hocking Co. and Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.
692. *Ranunculus arvensis* L. Corn Crowfoot. Painesville, Lake Co. Wm. C. Werner.
698. *Batrachium circinatum* (Sibth.) Rchb. Circinate White Water-crowfoot. Wayne Twp., Pickaway Co. Floyd Bartley and Leslie L. Pontius. Southern Madison Co. E. N. Transeau.
727. *Thalictrum revolutum* DC. Waxy Meadow-rue. Sugar Grove, Fairfield Co. Wm. C. Werner.
741. *Sarracenia purpurea* L. Pitcher-plant. Near Beach City, Sugar Creek Twp., Stark Co., W. H. Camp.
742. *Drosera intermedia* Hayne. Spatulate Sundew. Copley Swamp, near Akron, Summit Co. Specimen in Herbarium of Lake Erie College, Painesville, Ohio. Reported by Wm. C. Werner.
746. *Papaver dubium* L. Corn Poppy. Wakefield, Pike Co. "Abundantly escaped." Conrad Roth.
758. *Capnoides aureum* (Willd.) Ktz. Golden Corydalis. Little Mountain, Lake Co. Wm. C. Werner.
760. *Fumaria officinalis* L. Common Fumitory. Painesville, Lake Co. Wm. C. Werner.
762. *Berteroa incana* (L.) DC. Hoary Berteroa. Burton Twp., Geauga Co. Charles Dambach.
765. *Draba verna* L. Vernal Whitlow-grass. Painesville, Lake Co. Wm. C. Werner.
767. *Draba caroliniana* Walt. Carolina Whitlow-grass. Green Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
780. *Lepidium draba* L. Hoary Peppergrass. Sheffield, Ashtabula Co. L. E. Hicks.
781. *Lepidium perfoliatum* L. Perfoliate Peppergrass. Weed in cultivated field. Perry, Lake Co. Fred J. Tyler.
789. *Alliaria alliaria* (L.) Britt. Garlic-mustard. Sycamore Twp., Wyandot Co. C. W. Horton, Kingsville, Ashtabula Co. L. E. Hicks.

794. *Cheirinia repanda* (L.) Link. Repand Cheirinia. Geneva, Ashtabula Co. L. E. Hicks.
798. *Norta irio* (L.) Britt. Longleaf Hedge-Mustard. Perry, Lake Co. Fred J. Tyler. Buena Vista, Scioto Co. and Ashtabula Co. L. E. Hicks.
803. *Barbarea stricta* Andrz. Erect Winter-cress. Linton Twp., Coshocton Co. Frank B. Selby. Burton Twp. Bog, Geuaga Co. L. E. Hicks, C. Dambach, and F. B. Chapman. Westerville, Franklin Co. L. E. Hicks.
814. *Arabis drummondii* Gr. Drummond's Rock-cress. Ohio State Univ. grounds (1893), Columbus, Franklin Co. Wm. C. Werner. Fayette and Tuscarawas Twp., Coshocton Co. Frank B. Selby.
837. *Brassica napus* L. Rape. Circleville Twp., Pickaway Co., Ross Co., Jackson Co., Floyd Bartley and Leslie L. Pontius.
839. *Diplolaxis tenuifolia* (L.) DC. Wall Rocket. Saybrook, Ashtabula Co. L. E. Hicks.
840. *Raphanus raphanistrum* L. Wild Radish. Richmond Center, Ashtabula Co. L. E. Hicks and F. B. Chapman.
851. *Geranium dissectum* L. Cut-leaf Crane's-bill. Painesville, Lake Co. Otto Hacker. Sent in by Wm. C. Werner.
855. *Erodium cicutarium* (L.) L'Her. Stork's-bill. West Union, Adams Co. Conrad Roth.
862. *Oxalis acetosella* L. White Wood-sorrel. Pymatuming Swamp, Ashtabula Co. Collected in 1892. Wm. C. Werner.
871. *Tribulus terrestris* L. Land Caltrop. Holland, Lucas Co. Laura Rasmussen.
880. *Polygala polygama* Walt. Racemed Milkwort. Painesville, Lake Co. Wm. C. Werner.
887. *Phyllanthus caroliniensis* Walt. Carolina Phyllanthus. Serpent Mound, Adams Co. and Springfield Twp., Ross Co. Leslie L. Pontius and Floyd Bartley.
890. *Acalypha ostryaefolia* Raf. Hornbeam Three-seeded Mercury. Trenton, Butler Co. O. D. Diller.
919. *Malva alcea* L. European Mallow. Painesville, Lake Co. Wm. C. Werner.
929. *Hibiscus oculiroseus* Britt. Crimson-eye Rose-mallow. Pedro, Lawrence Co. Leslie L. Pontius and Floyd Bartley.
951. *Ascyrum hypericoides* L. St. Andrew's-cross. In woods bordering Peach Mountain, Adams Co. Katie M. Roads.
953. *Crocanthemum canadense* (L.) Britt. Canada Frostweed. Turkey Foot Lake, Summit Co. L. E. Hicks, and F. B. Chapman.
971.1. *Viola arvensis* Murr. Field Pansy. From Europe. "A bad weed." Burton Twp., Geauga Co. L. E. Hicks and C. Dambach.
982. *Viola hirsutula* Brain. Southern Wood Violet. Mouth of Moxahala Creek, Muskingum Co. E. S. Thomas.
989. *Viola pedata* L. Birdfoot Violet. Became established from plantings in a woodland before 1870, near Painesville, Lake Co. Specimen, collected by Alice Griswold in May 1884, sent in by Wm. C. Werner.
1002. *Alsine pubera* (Mx.) Britt. Great Chickweed. Rocky wooded hillside. Franklin Twp., Coshocton Co. Frank B. Selby.
1011. *Spergula arvensis* L. Corn Spurry. Sylvania, Lucas Co. Leona Kalp Wood.
1011.1. *Spergula sativa* Boenn. Spurry. Liberty Twp., Jackson Co. Adventive from Europe. Leslie L. Pontius and Floyd Bartley.
1022. *Silene dichotoma* Ehrh. Forked Catchfly. Wayne Twp., Ashtabula Co., Burton Twp., Geauga Co. L. E. Hicks, F. B. Chapman, and C. Dambach.
1028. *Silene wherryi* Small. Wherry's Catchfly. Franklin Twp., Adams Co. Edw. S. Thomas.
1103. *Pleuropterus zuccarinii* Small. Japanese Knotweed. Scioto Twp., Ross Co. Leslie L. Pontius and Floyd Bartley.
1124. *Polygonum buxiforme* Small. Shore Knotweed. Tuscarawas Twp., Coshocton Co. Frank B. Selby. Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.

1125. *Polygonum tenue* Mx. Slender Knotweed. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.
1133. *Dasiphora fruticosa* (L.) Rydb. Shrubby Cinquefoil. Bern Twp., Fairfield Co. E. S. Thomas, C. F. Walker and Robt. Goslin.
1134. *Potentilla paradoxa* Nutt. Bushy Cinquefoil. Cedar Point, Erie Co. In Deam Herb., Bluffton, Ind. Chas. C. Deam.
1142. *Comarum palustre* L. Purple Marshlocks. In County Line Bog. West Liberty, Champaign Co. L. E. Hicks and E. S. Thomas.
1151. *Rubus strigosus* Mx. Wild Red Raspberry. Oak openings. Spencer Twp., Lucas Co. Louis W. Campbell.
1165. *Spiraea alba* Du R. Narrow-leaf Spiraea. Bern Twp., Fairfield Co. E. S. Thomas.
1202.1. *Chaenomeles lagenaria* Koidz. (Cydonia japonica Hort.) Japanese Quince. Spreading from cultivation. "A large patch in a pasture lot probably started from the fruit." Liberty Twp., Highland Co. Katie M. Roads.
1239. *Baptisia leucantha* T. & G. Large White Wild-Indigo. West Union, Tiffin Twp., Adams Co. D. R. Dodd.
1278.1. *Meibomia laevigata* (Nutt.) Ktz. Smooth Tick-trefoil. Liberty Twp., Jackson Co., Colerain Twp., Ross Co. Floyd Bartley and Leslie L. Pontius.
1291. *Lespedeza nuttallii* Darl. Nuttall's Bush-clover. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.
1311. *Lathyrus myrtifolius* Muhl. Myrtle-leaf Marsh Pea. Buckeye Lake, Licking Co.; Columbus, Franklin Co. Wm. C. Werner.
1316. *Clitoria mariana* L. Butterfly-pea. Kettle Hills, Fairfield Co. E. S. Thomas and Chas. Goslin.
1322. *Phaseolus polystachyus* (L.) B. S. P. Wild Bean. Cyuahoga River, Akron, Summit Co. Wm. C. Werner.
1334. *Sullivantia sullivantii* (T. & G.) Britt. Sullivantia. Fultonham, Muskingum Co. Wm. C. Werner.
1343. *Ammannia coccinea* Rottb. Longleaf Ammannia. Circleville Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.
1344. *Rotala ramosior* (L.) Koehne. Rotala. Circleville Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley. Baumgardner's Pond, Jackson Twp., Franklin Co. Floyd B. Chapman.
1355. *Rhamnus lanceolata* Pursh. Lance-leaf Buckthorn. Hudson, Summit Co. Wm. C. Werner.
1365.1. *Ampelopsis heterophylla* (Thunb.) S. & Z. Variant-leaf Ampelopsis. From Eastern Asia. Escaped along a railway embankment, near a nursery. Painesville, Lake Co. Wm. C. Werner.
1373. *Nemopanthus mucronata* (L.) Trel. Mountain-holly. Lake Twp., Ashland Co. Leslie L. Pontius and Floyd Bartley.
1391. *Schmaltzia crenata* (Mill.) Greene. Fragrant Sumac. Kingsville, Ashtabula Co. L. E. Hicks.
1392. *Toxicodendron vernix* (L.) Ktz. Poison Sumac. Washington Twp., Lucas Co. Also in Swanton Twp. Louis W. Campbell.
1427. *Quercus marilandica* Muench. Black-Jack (Oak). McArthur, Vinton Co. E. S. Thomas.
1482. *Salix humilis* Marsh. Prairie Willow. Cedar Swamp, Champaign Co. Robert B. Gordon.
1484. *Opuntia opuntia* (L.) Karst. Common Prickly-pear. Patton Twp., Ross Co. Floyd Bartley and Leslie L. Pontius. Rollersville, Sandusky Co. C. W. Horton.
1488.1. *Schizophragma hydrangeoides* S. & Z. Schizophragma. Escaped near Painesville, Lake Co. Wm. C. Werner.
1495. *Grossularia oxyacanthoides* (L.) Mill. Smooth Gooseberry. Painesville, Lake Co. and Cedar Swamp, Champaign Co. Wm. C. Werner.
1496. *Grossularia hirtella* (Mx.) Spach. Low Gooseberry. Near Hudson, Portage Co. Floyd Bartley and Leslie L. Pontius.
1497. *Grossularia reclinata* (L.) Mill. Garden Gooseberry. Painesville, Lake Co. Wm. C. Werner.
1503. *Epilobium strictum* Muhl. Downy Willow-herb. Painesville, Lake Co. Wm. C. Werner.

1505. *Epilobium adenocaulon* Haussk. Northern Willow-herb. White's Gulch, Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

1507. *Oenothera oakesiana* Robb. Oakes' Evening-primrose. Painesville, Lake Co. Wm. C. Werner.

1513. *Kneiffia longipedicellata* Small. Long-pedicelled Sundrops. Edge of a swamp. Marshal Twp., Highland Co. Katie M. Roads.

1523. *Myriophyllum heterophyllum* Mx. Variant-leaf Water-milfoil. In marsh at Geneva, Ashtabula Co. L. E. Hicks.

1529. *Citrullus citrullus* (L.) Karst. Watermelon. Commonly spontaneous along railroads and in yards. Hillsboro, Highland Co. Katie M. Roads. E. Conneaut Beach, Ashtabula Co. L. E. Hicks.

1534.1. *Aristolochia clematitis* L. Birthwort. Escaped. From Europe. Perry, Lake Co. Fred J Tyler.

1538. *Ledum groenlandicum* Oeder. Labrador-tea. Thriving on Cranberry Island, Buckeye Lake, Licking Co. Clara Roush. Probably planted there by Dr. Freda Detmers.

1539.1. *Azalea canescens* Mx. Hoary Azalea. Burton Twp. bog, Geauga Co. L. E. Hicks, F. B. Chapman, and C. Dambach.

1547. *Chamaedaphne calyculata* (L.) Moench. Leather-leaf. Thriving on Cranberry Island, Buckeye Lake, Licking Co. L. E. Hicks. Probably planted there by Freda Detmers.

1553. *Chimaphila umbellata* (L.) Nutt. Pipsissewa. Two miles north of Brinkhaven, Jefferson Twp., Knox Co. E. M. Herrick.

1565.1. *Oxycoccus oxycoccus* (L.) MacM. Small Cranberry. Near Beach City, Sugar Creek Twp., Stark Co. W. H. Camp.

1566. *Gaylussacia frondosa* (L.) T. & G. Blue Huckleberry. Remove from the list. W. H. Camp who is making a special study of our Vacciniaceae considers its range as not extending into Ohio. "It does not occur outside the Atlantic drainage and the low costal plain of the Gulf Coast."

1572.1. *Gilia capitata* Dougl. Capitate Gilia. From the Pacific coast states. Escaped in a pasture lot where it is abundant. Hillsboro, Highland Co. Katie M. Roads.

1577.1. *Phlox carolina* L. Carolina Phlox. The variety is *P. carolina triflora* (Mx.) Wherry. "Edge of woods." Henley, Scioto Co. Katie M. Roads. Also Edgar T. Wherry. See below.

The following notes and records on species of Ohio Phlox have been received from Prof. Edgar T. Wherry of the Univ. of Pennsylvania, who is a special student of this group.

1574. *Phlox maculata* L. is now divided into two subspecies, *P. maculata odorata* (Sweet) Wherry, the northern, and *P. maculata pyramidalis* (Smith) Wherry, the southern one. In Ohio both occur, and although the boundary lies at approximately 40 latitude, there is much intermingling on both sides of this line. The most frequent and best known in the state is *P. maculata odorata*. The following records for *P. maculata pyramidalis* have been seen: Adams—E. Lucy Braun. Clark—both subspecies in O. S. U. Herb. Clermont—both subspecies in O. S. U. Herb. Fairfield—Lancaster, in U. S. National Herb. Franklin—Darby Creek west of Columbus, E. T. Wherry. Gallia—apparent intermediates between the two. Greene—O. S. U. Herb. Hamilton—apparent intermediates between the two. Hocking—O. S. U. Herb. Mahoning—Youngstown, Cornell U. Herb. Scioto—E. Lucy Braun. Stark—Canton, U. S. National Herb. The northern subspecies also represented in O. S. U. Herb.

1576. *Phlox glaberrima* L. The specimens represent the variety *Plox glaberrima interior* Wherry. Apparently all but two published records of *P. glaberrima* in Ohio really represent *P. carolina*. The two which stand are: Lucas—Swanton Twp., Mo., Bot. Garden Herb. Wood—Bowling Green, Moseley Herb.

1577. *Phlox ovata* L. The complete record for the species in Ohio is: Fulton and Highland, O. S. U. Herb. Lucas—Oak openings, U. S. National Herb., O. S. U. Herb.

1577a. *Phlox ovata carolina* (L.) Wherry. Change to No. 1577.1. *Phlox carolina* L. Carolina Phlox. Wherry has accepted the Linnean name and has established the variety *P. carolina triflora* (Mx.) Wherry. The county records are: Adams—Beaver Pond, Beech Fork, Cedar Fork, Turkey Creek, E. Lucy Braun. Butler—North of Oxford, O. S. U. Herb., Previously identified as *P. glaberrima* L. Highland—West of Fort Hill, Floyd Bartley and Leslie L. Pontius. Pike—Byington, Floyd Bartley and Leslie L. Pontius. Scioto—three-fourths mile S. E. of Pink. E. T. Wherry.

1579. *Phlox divaricata* L. Most of the Ohio material seen is the typical phase of the var. *P. divaricata canadensis* (Sweet) Wherry, with notched corolla-lobes, but Miss Braun reports a colony with entire lobes in Adams Co.

1582.a. *Phlox subulata australis* Wherry, Bartonia 11: 27. 1929. This is the basis of several reports of *Phlox brittonii* Small in Ohio. Apparently all collections from south of latitude 40 degrees ten minutes represent this plant. Herbarium material in other than the Ohio State Univ. collection is referred to here. Adams—Laurel Knob, Peach Mt., E. Lucy Braun. Delaware—two miles W. of Harlem, E. T. Wherry. Fairfield—Lancaster, in Gray Herb. Highland—Stultz Hill, three miles N. of Sinking Springs, E. T. Wherry, W. of Fort Hill, Brush Twp., Floyd Bartley and Leslie L. Pontius. Licking—two miles W. of Newark, E. T. Wherry. Ross—Liberty Twp., Floyd Bartley and Leslie L. Pontius.

1624. *Gentiana crinita* Froel. Fringed Gentian. Bern Twp., Fairfield Co. E. S. Thomas, C. F. Walker, and Robt. Goslin.

1630. *Gentiana villosa* L. Striped Gentian. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

1655. *Gonolobus laevis* Mx. Sandvine. Van Wert Co. Said to be a bad weed on two farms. E. N. Transeau.

1672. *Physalis pubescens* L. Low Hairy Ground-cherry. In an orchard, Marshal Twp., Highland Co., Katie M. Roads.

1673. *Physalis pruinosa* L. Tall Hairy Ground-cherry. In a field near May Hill, Adams Co. Katie M. Roads.

1687. *Penstemon pallidus* Small. Downy White Beard-tongue. Brush Twp., Highland Co. Floyd Bartley and Leslie L. Pontius.

1693. *Chelone montana elatior* (Raf.) P. & W. Mountain Turtle-head. Eagle Mills, Vinton Co. Leslie L. Pontius and Floyd Bartley. Old Man's Cave, Hocking Co. John H. Schaffner.

1701.1. *Gratiola viscidula shortii* Penn. Viscid Hedge-hyssop. Rock Run and White's Gulch, Liberty Twp. Jackson Co. Floyd Bartley and Leslie L. Pontius. Also Rock Run. R. B. Gordon.

1735. *Castileja coccinea* (L.) Spreng. Scarlet Painted-cup. Sphagnum Swamp. Mantua Twp., Portage Co. Almon N. Rood.

1747. *Catalpa catalpa* (L.) Karst. Common Catalpa. Mineral springs, Adams Co. Leslie L. Pontius, and Edw. S. Thomas.

1765. *Amsinckia intermedia* F. & M. Orange-flowered Amsinckia. "Introduced in a nursery." Painesville, Lake Co. Wm. C. Werner.

1792.1. *Verbena hybrida* Voss. Common Garden Verbena. Escaped near Saybrook, Ashtabula Co. Commonly cultivated. Lawrence E. Hicks.

1802. *Scutellaria serrata* Andr. Showy Skullcap. Conkle's Hollow, Hocking Co. E. M. Herrick. S. E. Corner of Jackson Co. L. E. Hicks.

1817. *Mentha alopecuroides* Hull. Wolly Mint. Conneaut, Ashtabula Co. L. E. Hicks.

1829.1. *Koellia verticillata* (Mx.) Ktz. Torrey's Mountain-mint. Liberty and Coal Twps. Jackson Co. Leslie L. Pontius and Floyd Bartley. Braceville Twp., Trumbull Co. Almon N. Rood, Barnesville, Belmont Co. Emma E. Laughlin.

1832. *Koellia mutica* (Mx.) Britt. Smooth-toothed Mountain-mint. Harpersfield Twp., Ashtabula Co. L. E. Hicks.

1844. *Meehania cordata* (Nutt.) Britt. Meehania. Perry Twp., Gallia Co. L. E. Hicks, E. S. Thomas, and C. F. Walker.

1854.1. *Stachys arenicola* Britt. Sand Hedge-nettle. On dry, sandy, clay bank; near Conneaut, Ashtabula Co. Lawrence E. Hicks.
1862. *Galeopsis tetrahit* L. Common Hemp-nettle. Plymouth, Ashtabula Co. L. E. Hicks.
1872. *Salvia pitcheri* Torr. Wild Blue Sage. Oak openings. Springfield Twp., Lucas Co. Emily and Bernard Campbell.
1878. *Plantago arenaria* W. & K. Sand Plantain. Growing in cinders along railroad. Perry, Lake Co. Fred J. Tyler.
1888. *Aralia hispida* Vent. Bristly Sarsaparilla. Phelps Creek, Ashtabula Co. L. E. Hicks, F. B. Chapman and C. Dambach.
1892. *Hydrocotyle umbellata* L. Umbellate Marsh-pennwort. Lake Punderson, Geauga Co. L. E. Hicks and F. B. Chapman.
1894. *Eryngium aquaticum* L. Rattlesnake-master. Kettle Hill, Bern Twp., Fairfield Co. Chas. and Robert Goslin.
1901. *Torilis anthriscus* (L.) Gmel. Erect Hedge-parsley. Painesville, Lake Co. Wm. C. Werner.
1935.1. *Cornus rugosa* Lam. Round-leaf Dogwood. Painesville, Lake Co. Wm. C. Werner.
1942. *Cynoxylon canadense* (L.). Dwarf Dogwood. Painesville, Lake Co. Wm. C. Werner.
1956. *Galium boreale* L. Northern Bedstraw. Bog at Kennard, Champaign Co. E. S. Thomas.
1963.1. *Galium labradoricum* Wieg. Labrador Marsh Bedstraw. Sphagnum bog; abundant. Mantua Twp., Portage Co. Almon N. Rood.
1980. *Viburnum cassinoides* L. Withe-rod. Near Beach City, Sugar Creek Twp., Stark Co. W. H. Camp.
1991. *Lonicera oblongifoldia* (Goldie) Hook. Swamp Fly Honeysuckle. Penn Line Bog, Ashtabula Co. L. E. Hicks.
2031.1. *Zinnia elegans* Jacq. Zinna. Spontaneous along the road. Liberty Twp., Highland Co. Katie M. Roads.
2039.a. *Rudbeckia laciniata hortensia* Bail. Golden-glow. In a pasture lot, western part of Scioto Co. Katie M. Roads.
2057. *Helianthus strumosus* L. Paleleaf Wood Sunflower. In Prairie. Pitt Twp., Wyandot Co. Robert McCormick and Edw. S. Thomas.
2070. *Cosmos bipinnatus* Cav. Cosmos. Escaped to waste ground north of Columbus, Franklin Co. John H. Schaffner. In Scioto and Ross Counties. Katie M. Roads.
2082. *Coreopsis lanceolata* L. Lanceleaf Tickseed. Painesville, Lake Co. Wm. C. Werner.
2084. *Coreopsis major* Walt. Greater Tickseed. Introduced in a nursery. Perry, Lake Co. Wm. C. Werner.
2099. *Gaillardia pulchella* Foug. Gaillardia. Escaped at Jefferson, Ashtabula Co. L. E. Hicks.
2116. *Grindelia squarrosa* (Pursh) Dun. Broadleaf Gum-plant. Pickaway Twp., Pickaway Co. Leslie L. Pontius and Floyd Bartley.
2116a. *Grindelia squarrosa serrulata* (Rydb.) Steyermark. Our specimens of Grindelia from Huron and Muskingum counties belong to this variety, as determined by Julian A. Steyermark of the Missouri Bot. Garden.
2125. *Solidago odora* Ait. Sweet Goldenrod. White's gulch, Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.
2128. *Solidago rigidiuscula* (T. & G.) Port. Slender Showy Goldenrod. Harrison Twp., Champaign Co. E. N. Transeau, M. B. Trautman, and Edw. S. Thomas.
2131.1. *Solidago altissima* L. Tall Goldenrod. Painesville, Lake Co. Wm. C. Werner.
2136. *Solidago neglecta* T. & G. Swamp Goldenrod. Northfield, Summit Co. Fred J. Tyler.
2139. *Solidago ohioensis* Ridd. Ohio Goldenrod. Bern Twp., Fairfield Co. E. S. Thomas.
2156. *Aster drummondii* Lindl. Drummond's Aster. South of O'Shaughnessy Dam, Washington Twp., Franklin Co. Edw. S. Thomas.
2157. *Aster undulatus* L. Wavy-leaf Aster. Green Twp., Monroe Co., Marietta, Washington Co., Elk Run Twp., Columbiana Co., Union Twp., Knox

Co. E. S. Thomas. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

2172. *Aster salicifolius* Lam. Willow Aster. On prairie. Big Island, Marion Co. Robert McCormick and Edw. S. Thomas.

2189.1. *Eupatorium album* L. White Thoroughwort. Liberty Twp., Jackson Co. Floyd Bartley and Leslie L. Pontius.

2195. *Eupatorium aromaticum* L. Smaller Snake-root. Liberty Twp., Jackson Co. Leslie L. Pontius and Floyd Bartley.

2198.1. *Kuhnia glutinosa* Ell. Glutinous False Boneset. Liberty Twp., Ross Co. Floyd Bartley and Leslie L. Pontius. Kennard, Champaign County, E. S. Thomas.

2202. *Lacinaria spicata* (L.) Ktz. Dense Blazing-star. Tuscarawas Twp., Coschocton Co. Frank B. Selby.

2223. *Artemisia ludoviciana* Nutt. Western Mugwort. Paint Twp., Highland Co., Katie M. Roads. Jasper, Pike Co. L. E. Hicks.

2235. *Synosma suaveolens* (L.) Raf. Sweet-scented Indian-plantain. Bern Twp., Fairfield Co. E. S. Thomas, C. F. Walker and Robt. Goslin.

2255. *Centaurea jacea* L. Brown Star-Thistle. Thompson, Geagua Co. J. G. Binnig.

2259. *Centaurea maculosa* Lam. Spotted Star-thistle. Roadside weed. Painesville, Lake Co. Fred. J. Tyler and Harriet B. Tyler.

2278. *Hieracium marianum* Willd. Maryland Hawkweed. Stow corners, Summit Co. Floyd Bartley and Leslie L. Pontius.

2282. *Hieracium pratense* Tausch. Field Hawkweed. North Central Trumbull Co. L. E. Hicks and F. B. Chapman. Burton Twp., Geauga Co. Chas. Dambach.

2285. *Hieracium greenii* Port. & Britt. Green's Hawkweed. Conneaut, Ashtabula Co. L. E. Hicks.

2285.1. *Crepis pulchra* L. Small-flowered Hawksbeard. Manchester, Adams Co. From Europe. Conrad Roth.

2300. *Lactuca villosa* Jacq. Hairy-veined Blue Lettuce. Clarksville, Clinton Co.; Fort Ancient, Warren Co.; Peach Mountain, Adams Co.; Ripley, Brown Co.; Cincinnati, Hamilton Co. Katie M. Roads. Buchtel, Athens Co. Len. Stephenson.

Physical Geology.

This book is not to be confused with the one with the sam title by Longwell. This new book is based on Physical Geology by Longwell, Knopf & Flint. It follows the same order as the parent text and differs considerably from the other "Outlines." The Chapters are as follows: I, Geology, the Science of the Earth; II, Weathering as a Part of Erosion; III, Streams and Valleys; IV, Subsurface Water; Lakes and Swamps; V, Glaciation; VI, Wind as a Geologic Agent; VII, The Sea; VIII, Sedimentary Rocks; IX, Igneous Rocks and their Mode of Occurrence; X, Volcanoes and Volcanism; XI, Diastrophism and Its Effects; XII, Earthquakes; The Earth's Interior; XIII, Metamophism; XIV, The Structure and History of Mountains; XV, Land Forms; XVI, Mineral Resources; Appendix A, Minerals; B, Topographic Maps.

The divorcing of Wind from Weathering is a great help because where the two are considered in one chapter the student often becomes confused and gets the impression that wind erosion is weathering. The inclusion of Lakes and Swamps in the same chapter as Subsurface Water may lead to the same confusion although the text is very clear. The Chapter on Mineral Resources is a wise inclusion as is the Appendix on Topographic Maps. The authors have made an excellent abridgement of their Physical Geology and we feel that where the shorter text is desirable that this new Outlines is very usable and well arranged.—Willard Berry.

Outlines of Physical Geology, by C. R. Longwell, A. Knopf and R. F. Flint. v + 356 pp. New York, John Wiley and Sons, 1934. $3.00.

THE PRESENT STATUS OF CRYOLITE AS AN INSECTICIDE.

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INTRODUCTORY.

For many years arsenicals have been used as stomach poisons for the control of chewing insects. These were first discovered accidentally and at that time (about 1860) arsenic was used in a rather soluble form in spray materials like Paris Green and London Purple. In view of the injury to foliage caused by these materials and the consequent limited way in which they could be used for insect control a direct effort was made in 1885 in connection with the Gypsy Moth problem in Massachusetts to find an arsenical which was comparatively insoluble. As a result Arsenate of lead was first made and used in 1892 to control chewing insects and this was adopted as a standard material and was recommended and used almost exclusively for the control of chewing insects until the period of the world war. Then a demand was made for a cheaper arsenical because of the high price of lead. At that time calcium arsenate and other cheaper materials were manufactured. But these contained a larger percentage of water soluble arsenic than could be tolerated by plants and continued to injure foliage. In 1925 the toxic effects and the cumulative toxicity effect of both lead and arsenic upon the human body were being recognized by toxicologists.

Although the British government as early as 1903 had fixed a tolerance of 1.429 mg. of As_2O_3 residue per kilogram of food stuff (equivalent to .01 grams per pound) this was practically ignored until 1925 when England threatened an embargo on American fruit. This was soon followed by the establishment of the same tolerance on both fruits and vegetables by the U. S. Pure Food and Drug Administration. Although the lead tolerance has been changed for 1934 to 0.019 grains of lead per pound, the arsenic tolerance of 0.01 grains of arsenious oxide has remained as in 1933.

In view of this situation there has been widespread search for substitutes both in the field of organic contact insecticides and in an attempt to find a good nonarsenical stomach poison.

The ideal insecticide should be a substance with a high acute toxicity to a wide variety of insects, be non-injurious to plants and have no effect upon man. This will probably never be attained since all three of these are fundamentally alike biologically. In view of the lack of such an insecticide we have been required to consider these upon the basis of their relative toxicity to man and select an insecticide which seems to be the lesser evil.

On this basis fluorine compounds have been thoroughly tested during the past few years and two especially, cryolite

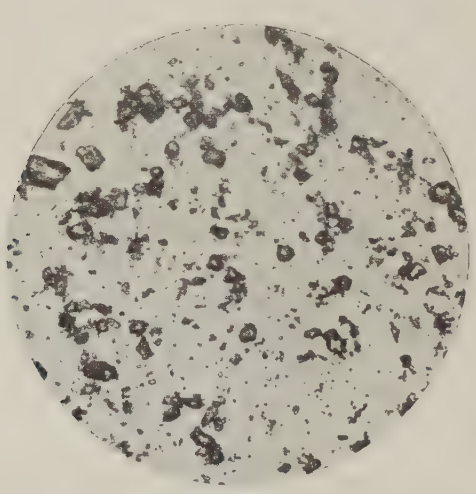

FIG. 1. Showing the variation in the size of particles of natural cryolite when ground. (Greenland.)

and barium fluosilicate, have seemed to fit more nearly the requirements and be most promising because of their margin of safety on foliage, their relatively high toxicity to insects and their relatively low toxicity to man when compared with arsenate of lead.

PHYSICAL AND CHEMICAL PROPERTIES.

Cryolite (Na_3AlF_6) is one of the fluoalumnates of an alkali metal. The other possible combinations are postassium hexafluoaluminate (K_3AlF_6) Ammonium hexafluoaluminate $(NH_4)_3$ AlF_6 and lithium hexafluoaluminate (Li_3AlF_6).

Insecticides containing water insoluble double fluorides of the alkali metals with Aluminum are obtained by treating

water insoluble Aluminum compounds such as Al_2O_3 with alkali metal compounds such as KOH in suspension in the presence of water and gaseous H. F. or its aqueous solution and drying and comminuting the gel thus formed (Carter 14).

Cryolite occurs in two forms, natural and synthetic. It occurs in Greenland as a native fluoride of Aluminum and sodium. More than 10,000 tons are used annually for the manufacture of aluminum, the fused mineral being used as the bath for the electrolysis of alumina to the metal. Cryolite is also used as flux in the manufacture of white Portland cement,

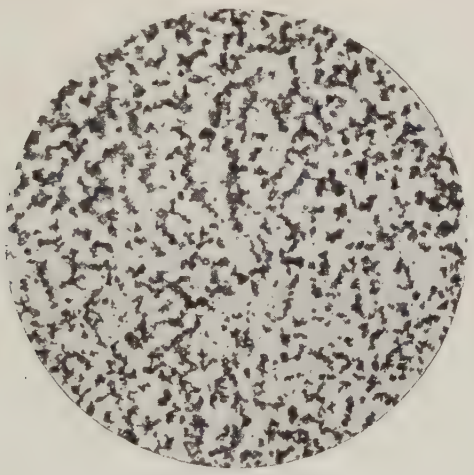

FIG. 2. Showing the uniformity of size of particles in synthetic cryolite. (Jungmann and Co. product.)

in the enameling of iron ware and in the manufacture of opaque white glass.

The natural cryolite when ground is a heavy powder with uneven sized particles (Fig. 1) and is therefore not well adapted to insecticidal purposes.

The synthetic powdered material is light and nearly uniform in composition (Fig. 2) and has a solubility of 1 gram to 1.639 cc. of water. It is available in commercial quantities. It contains the following chemicals:

Sodium aluminum fluoride	98.20%
Silica	.74%
Sodium sulphate	.36%
Iron oxide	.06%
Moisture	.64%

Both natural and synthetic cryolite are almost transparent in water suspensions. Cryolite appears soluble because the refractive indices of water and cryolite are nearly identical.

When properly washed during the process of manufacture, suspensions or solutions of these compounds in water give a practically neutral reaction and as their solubility is low they are less likely to injure or burn plant foliage than such compounds as the fluosilicates. Considering their fluorine content alone as a measure of toxicity they compare favorably with the fluosilicates and metallic fluorides which have a definite insecticidal value.

Aqueous solutions of Barium Fluosilicate have a corrosive effect upon spray pumps. In order to overcome this situation the Grasselli Chemical Company have obtained a patent (No. 1,931,367) which covers the addition to their Barium Fluosilicate of a slightly water soluble substantially neutral fluoride. Synthetic cryolite is a material of this type and can be used for this purpose.

THE RELATIVE TOXICITY OF SOME FLUORINE COMPOUNDS AS STOMACH INSECTICIDES.

In attempting to estimate the relative toxicity of the more important fluorine compounds Shepard and Carter (61) have determined the median lethal dose range of each material on the basis of mg. per gram. The median lethal dose of acid lead arsenate is about 0.09 mg. per gram and is given here in order that the relative fluorine toxicities as specified below may be compared on that basis:

		Solubility at 25° C. grams per 100 cc.	Medial Lethal Dosage Range mg. per gram
FLUORIDES—			
Sodium	NaF	4.054	0.11–0.15
Manganese	MnF_2	.186	.20– .40
Lead	PbF_2	.066	.25– .40
Magnesium	MgF_2	.013	.57
FLUOSILICATES—			
Sodium	Na_2SiF_6	.762	.10– .13
Potassium	K_2Sif_6	.177	.07– .10
Barium	$BaSiF_6$	.025	.09– .12
FLUOALUMINATES—			
Sodium	$Na_3Al\ F_6$	.061	.05– .07
Potassium	$K_3Al\ F_6$	.158	.08– .10
Ammonium	$(NH^4)_3Al\ F_6$	1.031	.11– .14

It will be noted from the above figures that sodium fluoaluminate or cryolite shows the lowest range median lethal dose and is therefore practically twice as toxic relatively as arsenate of lead.

COMPATIBILITY OF THE FLUOSILICATES AND CRYOLITE WITH ARSENICALS.

The use of combined arsenates and fluorine compounds has been suggested in the hope that additional insect control might be secured and that the arsenical residue might also be reduced.

Carter (11) has published certain data concerning these combinations. He finds that fluosilicates in solution have an acid reaction and in general are much more soluble than the arsenates used in insect control. In solution they are used at the rate of 1 pound each to 45.8 gallons of water. Severe injury to vegetation may be caused by excessive amounts of soluble arsenic or by solutions having an acid reaction. The solutions were analyzed for both of these factors and he found that with lead arsenate there seemed to be a tendency for the fluorine compounds to form less soluble arsenic than is formed in tap water alone. The other fluosilicates and other arsenates were largely decomposed. The presence of cryolite decreased slightly the amount of soluble arsenic formed by all the arsenates used in these experiments. Barium fluosilicate caused the formation of smaller amounts of soluble arsenic than the fluosilicates of sodium, potassium or calcium. This was probably due to its lower solubility. Cryolite gave a low acidity reaction with all the arsenates tested and it also showed a low soluble arsenic content when mixed with these materials.

COMPATIBILITY WITH FUNGICIDES.

It is frequently necessary to mix insecticides and fungicides together in the same spray in order to control insects and plant diseases. Marcovitch has mixed cryolite at the rate of 1½ pounds to 50 gallons of water in a lime sulphur spray at the rate of 1 to 40 without causing injury. When used at the same strength with Bordeaux mixture 3-3-50 no foliage injury was caused. Fish oil at the rate of 1 pound to 4 pounds of cryolite may be used safely as a sticker and greatly improves the adhesive qualities of the spray.

PLANT INJURY OR BURNING.

Many types of chemicals cause foliage injuries when used as dusts or sprays. As a rule more injury is caused by the material in spray form and in general materials that are readily soluble in water are more apt to burn. On the other hand a highly insoluble material usually shows poor toxicity and is not a good insecticide. The margin of safety between a good insecticide and a safe material upon plants is so small that only a few known chemicals even approach the required specifications. Cryolite with a solubility of 1-1639 and barium fluosilicate with a solubility of 1-3750 have proven relatively safe on foliage by tests conducted to date and have shown a rather high degree of toxicity to insects. When used as a spray upon bean foliage at the rate of 2 or 3 pounds to 50 gallons, Howard, Brannon and Mason have shown they produce no injury. When used as a dust at the rate of 6 to 12 pounds per acre Marcovitch has shown there is no injury to bean or potato foliage, but that injury occurred when amounts greater than 20 pounds per acre were used.

According to Marcovitch different plants will very ragarding their susceptibility to burning by fluorine compounds. Cotton seems to be the most resistant, followed by beans, cabbage, apple, potato, tobacco, cucumber, peanuts, peach and smartweed. The latter is unusually sensitive to fluorine compounds.

Various workers attempting to control several different insect pests have found cryolite safe to most foliage in general. Specific reference is made to these findings in several places under specific insects mentioned in the following discussion.

Barium fluosilicate is considered safer than cryolite by some investigators, but according to Dr. N. F. Howard, burning resulted in several instances on bean during 1933 with Barium fluosilicate and W. L. Brannon found dahlias injured by the same material during 1933.

POISONOUS EFFECTS OF FLUORINE ON MAN AND ANIMALS.

When fruits and vegetables are sprayed with fluorine compounds and ingested how poisonous are they to man? This question has been variously answered by different workers. There is reason to believe that cryolite and barium fluosilicate are less toxic than sodium fluosilicate. Experimental work by Sollman and others working with animals which were fed

sodium fluosilicate in large doses indicates that the soluble arsenicals such as sodium arsenite are nine times more toxic than sodium fluosilicate.

Marcovitch has stated (44) that according to Gautier and Clausman the average spray residue of fluorine compounds contain less than 3 parts of fluorine per million of food stuffs while natural foods contain on the average 26.5 parts of fluorine per million. Since therefore we are apparently consuming more fluorine in our daily diet than would be possible from the consumption of fruits and vegetables sprayed with fluorine, these sprayed materials should offer no additional health hazards.

Both fluorine and arsenical compounds have high acute toxic values as indicated by the following figures (Marcovitch 44).

Acute toxicities (from Kuhn (Trans. Fourth Int. Ent. Congress 1928) and Muechlberger (Jour. Pharm. & Expt. Ther. 1930).

	M. L. D.	
Calcium arsenate	38 mg. per Kilo (dogs).	Kuhn.
Lead arsenate	500 mg. per Kilo (dogs).	Kuhn.
Lead arsenate	75 mg. per Kilo (rabbits).	Muehlberger.
Sodium fluosilicate	150 mg. per Kilo (dogs).	Kuhn.
Sodium fluoride	200 mg. per Kilo (rabbits).	Muehlberger.
Barium fluosilicate	175 mg. per Kilo (rabbits).	Muehlberger.
Cryolite	500 mg. per Kilo (not fatal).	Marcovitch.

In considering the residue problem we are primarily concerned with Chronic toxicities. According to Marcovitch the fluorine compounds are at least 100,000 times safer than lead arsenate in this respect, and possess a marginal safety factor over the average spray residue content of 75.

The situation in California is apparently considered in the same light if we may judge from the following quotation taken from the 1931 Annual Rept. of the Calif. Agr. Exper. Sta., concerning the problem of fluorine spray residues. "From a number of chemical analyses made by the Bureau of Chemistry at Washington, D. C., it would seem that on vegetables which are washed before marketing, there is not sufficient residue to be dangerous for human consumption even though dusted excessively."

On the other hand Carter (13) states that in the Pacific Northwest where there is very little rain during the growing

season and where as many as 6 or 7 sprays are applied ranging from 2 to 4 pounds per 100 gallons of water during each application, the spray residue builds up to a considerable amount especially when oils are used. Under these conditions, the spray residue on fruit has run very high, but fluorine compounds do not leave as much residue on sprayed fruits as arsenical sprays. However when oils are used considerable residues result. The maximum found when barium fluosilicate was used was 0.927 grains of barium fluosilciate per pound of fruit. This is equivalent to 53.9 parts per million. Normal spraying however usually shows 0.15 grains of barium fluosilicate per pound (equivalent to 8.7 parts per million. Washing usually leaves about 2.1 parts per million. Cryolite contains 1.3 times as much fluorine as barium fluosilicate.

Investigators have differed considerably regarding the use of fluorine in one form or another when fed to or injected in man and animals. Baldwin (2) and McNally (40) have reported several cases of fluorine poisoning in man. Blaizot (5) Wieland and Kurtzohn (77) and Marcovitch (45) studied the lethal doses of different forms of fluorine for rabbits. Heidenhain (31) has reported on the lethal effects of sodium fluoride in dogs. By using sublethal doses of fluorine in different forms, Sollmann, Schetter and Wetzel (69) Bergara (4), Shultz and Lamb (60) and McClure and Mitchell (38) observed an impairment of growth and feed consumption in rats.

Several investigators have studied the effects of fluorine on the different organs and tissues of the body. Brandl and Tappeiner (9) could find no histological changes in the blood, liver, kidneys or muscles of a dog fed varying amounts of sodium fluoride. The same investigators found no evidence of histological change in the bones. Sollman, Schettler, and Wetzel (69) were unable to find histological lesions in rats fed 8 mg. of sodium fluoride per kilogram of body weight daily for 9 weeks. Pitotti (51) observed a degeneration of the epithelium of the kidneys and a cloudy swelling of the liver in rabbits and guinea pigs fed lethal doses of sodium fluoride. Weinland (76) reported that the mucous membrane of a frog was killed by a 2.1 per cent solution of sodium fluoride. Goldemberg (23) reported that the feeding of sodium fluoride caused an increase in the size of the thyroid glands of dogs and rats, but these results could not be verified by Chaneles (15) and Tolle and Maynard (74).

Several investigators, Schulz and Lamb (60) McCollum, et al (39) Bergara (4) and Tolle and Maynard (74) have shown the specific effect of fluorine on the teeth of rats. The incisors became soft, elongated, and lost their normal pigimentation. The teeth of dairy cattle also became soft and showed excessive wear when rock phosphate containing fluroine was fed according to Taylor (73) and Huffman and Reed (33). The effect of fluorine ingestion on human teeth when obtained in water supply has been reported by Smith, Lantz and Smith (63, 64 and 65).

They found that mottled enamel of the teeth is endemic at St. David, Ariz. and has been produced in experimental animals by water from that region. Chemical examination of the water showed the presence of 3.6—7.15 mg. of fluorine per 1 of water while water from non endemic localities gave 0—0.3 mg.

The production of mottled enamel is attributed to the ingestion of fluorine in water and not to the food supply. The source is apparently rock phosphate and black mica both of which contain 3-5% of fluorine. Concentrations of fluorine above 2.7 parts per millinon were definitely toxic when ingested with drinking water.

Several investigators have attempted to find the effect of fluorine feeding on bone formation chiefly by using rock phosphate as a mineral supplement in animal nutrition. Hart and his associates (30) reported improved bone formation when rock phosphate was used to supplement low phosphorus rations for pigs. On the other hand Forbes and his coworkers (19) found that the feeding of rock phosphate to pigs produced less dense and weaker bones than when no minerals, or minerals practically free from fluorine, were fed. The weaker bones were characterized by maximum magnesium and phosphorus content and minimum calcium and carbon dioxide percentages. Reed and Huffman (52) demonstrated that the feeding of rock phosphate resulted in the thickening of the jaw and the metatarsal bones of dairy cattle. The work of McClure and Mitchell (38) showed an increase in the ash percentage of bones, accompanied by a slight decrease in the calcium content of the ash, in rats on high fluorine rations. Contrary to this work Tolle and Maynard (74) showed a decrease in the percentage of bone ash in rats fed a ration containing 1.8 per cent rock phosphate. They furthermore reported that

phosphatic limestone, containing approximately 1 percent fluorine was equal to a mixture of limestone and steamed bone meal for growth and bone formation in the pig.

McClure and Mitchell (38) found that fluorine in the form in which found in rock phosphate; namely, calcium fluoride, depressed calcium metabolism in the pig and that excessive fluorine intake also decreased growth and feed consumption.

Fluorine is a normal constituent of body tissues. This has been shown by Zdarek (80) Gaatier (22) Wrampelmeyer (79) Joblbauer (34) Harmes (29) and Sonntag (70).

Kick, Bethke and Edgington (36) have recently compared the feeding of fluorine salts with the natural mineral when each was used in comparable feeding experiments. They found growth impaired, bones weakened, teeth softened, and similar physiological effects were produced in swine by both materials. Rock phosphate however produced certain pathological changes in the kidney which sodium fluoride did not produce.

The recent work of Phillips, Alvin, Hart and Bohstedt (50) gave evidence to show that chronic fluorine poisoning does not inhibit reproduction in the rat and therefore any unfavorable effect upon reproduction arises secondarily as the result of a systematic reaction to fluorine. No clear cut and positive evidence is available to show that chronic fluorine poisoning has a cumulative effect upon reproduction or other physiological processes from generation to generation for as long as 5 generations.

The most striking thing about the experimentation with fluorine compounds upon animals is that the results obtained by apparently equally competent workers are highly contradictory which indicates that certain factors other than fluorine may have caused these differences. Also these workers have assumed that fluorine regardless of its source or condition should produce the same effect upon animal tissues whether ingested with water or food or injected into the body with a needle. Furthermore the changes which might take place due to the medium of the plant as is known to occur in the case of certain other chemicals used upon plants has not even been considered. It has been definitely demonstrated by field work that sodium fluoride and sodium fluosilicate are too soluble and too injurious to plants to be used generally in a

practical way, but that cryolite is insoluble and safe on plant foliage. Probably the same difference is to be found in the case of man but practically all of the experimental work performed to date has been done by using the soluble form, sodium fluoride. These experimental data as such are not applicable to the insoluble materials. It should be stated also that the European laws have already differentiated distinctly between 1, acid fluorides such as Ammonium bifluoride and Sodium bifluoride which are considered highly poisonous; 2, soluble neutral fluorides such as Sodium fluoride and Sodium Silica Fluoride which are held as mildly poisonous; and 3, the insoluble fluorides such as Synthetic cryolite which is considered as non-poisonous.

It should be borne in mind that the main question is the form in which fluorine appears. If the fluorides were as poisonous as to justify the tolerance dosage of 0.01 gram per pound of fruit, it would be impossible to manufacture cryolite under present conditions as the workmen are obtaining many times that amount during each production without having ever suffered injury to their health. Competent authorities also point to the fact that Calcium Fluoride which is similar to cryolite is generally and extensively prescribed in medicine. Also enamel and similar wares are used extensively which average a cryolite content of 10% and neither of these sources have been considered dangerous to human health.

In order to determine the relative toxicity of materials which cause acute poisoning or chronic intoxication in man it is necessary to experiment with as many forms of lower animals as possible and then assume that the toxicity in the case of man is no lower than in these experimental animals. Different materials may also cause different symptoms in the same species of animal so that loss of hair or other similar conditions may preclude more marked symptoms. If comparisons must be made, uniformity of experimental conditions should be adhered to. This apparently has been done in the case of the feeding experiments conducted by Smyth and Smyth (66).

They have published comparative toxicity data showing that the fluorine compounds are less toxic than lead arsenate. These experiments were apparently well planned and the best controlled of those dealing with fluorine compounds. They compared the relative toxicity of fluorine and arsenical insecticides by means of feeding experiments conducted on white

rats for a period of 16 weeks. As a basis for comparison they used behavior, appetite, fecundity, growth, tooth development and abnormality and organic pathology, and all of their data indicated that arsenical compounds are several times more toxic than fluorine compounds. According to their work the use of fluorine insecticides leaves a much wider margin of safety than the use of arsenical materials based on the relative weight of spray residue to the fruit and the consequent amount toxic to the consumer. These conclusions should probably be considered as a more conservative estimate.

There is still some doubt concerning the question of ingestion of small amounts of fluorine or arsenic. The data available indicate that the extremely small amounts of arsenic that may be found on sprayed fruits are harmful when administered over a period of six months. On the other hand the continued feeding to guinea pigs of sodium fluoride in small amounts such as may be found on sprayed apples, appeared harmless even after several years. It seems therefore that the poisonous nature of fluorine compounds in small amounts that may occur on sprayed fruits is negligible from the standpoint of human health as far as conclusive data are available.

RESULTS OF EXPERIMENTAL WORK IN THE CONTROL OF INSECT PESTS.

During the past four years cryolite and several other forms of fluorine have been used extensively to test their effectiveness in controlling some of the most important pests of fruits and vegetables, especially in the United States and other agricultural areas. Three things have been sought especially.

1. A non-arsenical substitute for lead arsenate and other arsenicals.
2. A material which gave a high toxic value in controlling insects.
3. An insecticide which gave very slight or no foliage injury.

A brief summary of some of the results obtained by various workers on specific insect problems is cited here. Although both natural and synthetic cryolite have been used in these experiments, the greater part of this work has been performed with a synthetic cryolite known as Syncrolite and manufactured by Jungmann and Co.

The Codling Moth (Carpocapsa pomonella).

The Codling moth is probably one of the most difficult insects which the grower has to control at the present time, and the spray residue problem of lead arsenate has presented a puzzling situation. Newcomer (46) has found in his experiments at the Washington State Experiment Station that certain fluorine compounds are as effective as lead arsenate in the control of codling moth on apples in the arid regions of the Pacific Northwest. Three or four of these compounds have given rather satisfactory results. Cryolite and Barium fluosilicate are two of this number which are available and suitable for use. At present the cost of cryolite is slightly higher than lead arsenate. But it does not injure the plant nor does it affect the color, size or quality of the fruit. Furthermore the fluorine residues are easily removed with alkaline washes. They can be used satisfactorily in the second brood sprays (5th and 6th cover) at the rate of 4 pounds to 100 gallons of water combined with one pint of fish oil, or 3 pounds to 100 gallons of water with one gallon of summer oil.

In later investigations (47) he found that after July instead of oil being used with lead arsenate, cryolite may be used at the rate of 3 pounds to 100 gallons of water. In 1931 cryolite proved very effective and in some cases more so than lead arsenate.

Webster, Marshall and Hansburg (75) working in the same area found that arsenates with oils gave heavy residues but good control of codling moth. They also state that spraying throughout the season with 3 pounds of natural cryolite to 100 gallons of water plus one quart of fish oil gave slightly better results than the normal lead arsenate sprays.

Gross and Fahey (24) have reported synthetic cryolite to have marked insecticidal properties for codling moth, but its effectiveness decreases more rapidly than that of lead arsenate.

Barrett working in California (3) has carried on experiments for the control of the codling moth on Walnuts. He found that barium fluosilicate and synthetic cryolite are the only fluorine compounds of those tested (including a large series) which show promise for use in controlling this pest on Walnut. Used as a dust at the rate of 35% with 65% of a 400 inch mesh Talc each gave good results. Each gave about 90% control and neither gave foliage injury.

Pettey (48) working in South Africa found that in cases of severe infestation of codling moth lead arsenate at the rate of 1¼ pounds in 40 gallons of water applied fortnightly throughout the season is not satisfactory as a control for codling moth. If the arsenate of lead is doubled more satisfactory results are obtained in control, but the residue is difficult to remove. In using an artificial cryolite from Germany at the rate of 2 pounds with ¼ pint of fish oil in 40 gallons of water and applied at intervals of 3 weeks throughout the season he obtained more satisfactory results than with a similar normal program of lead arsenate alone. In addition it appeared to reduce infestations of mealy bug (Psuedococcus maritimus) considerably.

At a later date (49) he stated that artificial cryolite was not as effective as lead arsenate in controlling Codling Moth in Highveld orchards, but it caused no foliage injury, whereas the arsenate sprays did considerable damage. The results indicated that cryolite is more effective in control in arid summer coastal regions than in those where summer rainfall occurs.

Joubert (35) working in South Africa found in 6 of 7 comparative experiments that cryolite sprays used at the rate of 2 pounds to 40 gallons gave them from 3 to 25 per cent better control of codling moth on pears than Lead Arsenate sprays.

The fruit growers in the North West depend upon using cryolite and similar fluorine compounds for the early season sprays, because when lead arsenate alone is used for all seven or more sprays it is impossible to prevent the lead arsenate residue from becoming greater than the tolerance limits (.014 gms. for lead and .01 gms. for arsenic).

Experiments on peach for the Control of Oriental Fruit Moth (Clydia (Laspeyresia) molesta Busk) and the Plum Curculio (Conotrachelus nenuphar Hbst).

The foliage of the peach is usually sensitive to arsenate of lead which has been used for plum curculio and the residue problem is difficult to overcome. Defoliation of the tree has always been a problem with arsenate of lead. In 1929 Swingle (72) showed that arsenic was found to act as a cumulative poison within the peach leaves. Acid lead arsenate when used alone in proportions of 1 pound to 50 gallons caused very

severe injury even when soluble arsenic was as low as .04% as arsenic pentoxide.

Snapp (67) used sodium fluosilicate at the rate of 2 pounds to 50 gallons and found it very toxic to curculio but also to the fruit and foliage of the peach.

Subsequently, Marcovitch, Stanley and Anthony (43) found in experiments performed in Tennessee that cryolite sprayed plots showed no trace of injury. In 1929 and in 1930 as many as 7 spray applications did not give the slightest degree of burning at the rate of one pound to 50 gallons.

Barium fluosilicate was about as safe as cryolite but with fish oil soap gave defoliation. The curculio was controlled equally well with arsenate of lead and cryolite while the oriental fruit moth was controlled better with cryolite. The cryolite sprayed plot also showed a noticeable reduction of *Bacterium pruni* (bacterial disease of peach) and thus exhibited bacteriocidal properties. The more rapid insecticidal action of cryolite and barium fluosilicate is shown by the fact that 100% mortality results in two or three days when curculios are fed upon foliage treated with these fluorine compounds while arsenate of lead treated foliage upon which they fed did not cause 100% mortality for two or three weeks time.

After obtaining a complete defoliation with 4 arsenate of lead sprays Marcovitch and Stanley working in Tennessee (45) used barium fluosilicate and cryolite as substitutes for arsenate sprays in controlling the Oriental fruit moth and plum curculio on peach. They found that dusts were not as satisfactory as sprays, largely due to weather conditions and that four sprays of cryolite and sulphur gave satisfactory control of both pests.

Snapp and Thomson (68) working in Georgia on peach report that synthetic cryolite at the rate of 2 pounds to 50 gallons caused no injury to foliage or budwood and gave almost as good control as potassium fluosilicate. Cryolite was the least toxic of the three fluorines used and potassium fluosilicate was the most toxic. Wettable sulphur apparently increases the toxicity of these fluorine compounds.

Frost of Pennsylvania obtained unfavorable results by using Sodium aluminum fluoride for oriental fruit moth on peach at the rate of 3 pounds to 100 gallons of water. He states that considerable burning resulted and a high percentage of control was not obtained as it ranged from 37% to 80%.

The Walnut Husk Fly (Rhagoletes completa Cress).

The walnut husk fly is probably one of the two or three most serious pests of the walnut industry in California. It has been introduced rather recently. Boyce (6, 7, 8) has been working on this project and making rather extensive control investigations during the past three or four years.

In 1930 the arsenicals tested were effective in causing insect mortality but all except the basic arsenate of lead caused foliage injury. The speed of their toxic action bears a direct relationship to their arsenic content and degree of solubility in water. During the same season cryolite in dust and spray form gave practically as good results as barium fluosilicate,

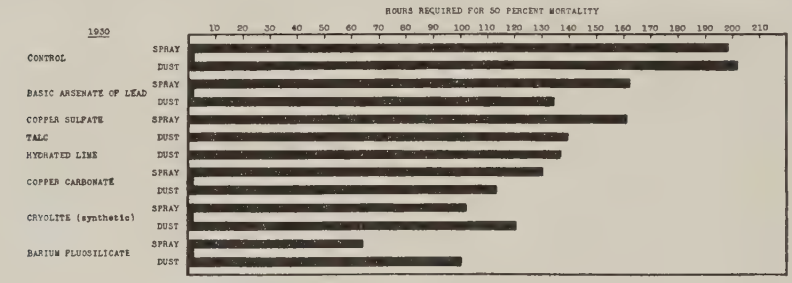

FIG. 3. After Boyce, Monthly Bull. Dept. Agr. Calif. 20: 686, 1931. Results of toxicity studies in 1930, showing number of hours required to bring about 50 percent mortality of adults in Rhagoletis completa Cress. Data based on average of 55 experiments in which a total of 1,944 flies was used. Average of 35 flies per experiment.

but nothing else proved as satisfactory as these two materials (Figs. 3, 4, 5). Both were safe to use on plants. The speed of toxic action is correlated with the solubility of the material in water, the more soluble producing the more rapid lethal action. Calcium fluoride and calcium fluosilicate were not effective.

The results obtained the next year showed that cryolite and barium fluosilicate exhibited similar speed of toxic action and gave better results than the other materials tested. In speed of action natural cryolite was considerably inferior to the synthetic cryolite in these tests.

Later results (1932) showed that all of the arsenicals used (acid lead arsenate, basic lead arsenate, calcium arsenate, magnesium arsenate, manganese arsenate, sodium arsenite) except basic lead arsenate caused foliage injury and this one

was consistently slowest in speed of lethal action. Boyce makes the following statement, "of the fluorines tested sodium fluoaluminate (cryolite, synthetic) barium fluosilicate and potassium fluoaluminate were the most promising from the point of view of toxicity to the insect and tree tolerance." The accompanying diagram (Fig. 6) published by Mr. Boyce shows that these three were most effective in the order named, cryolite

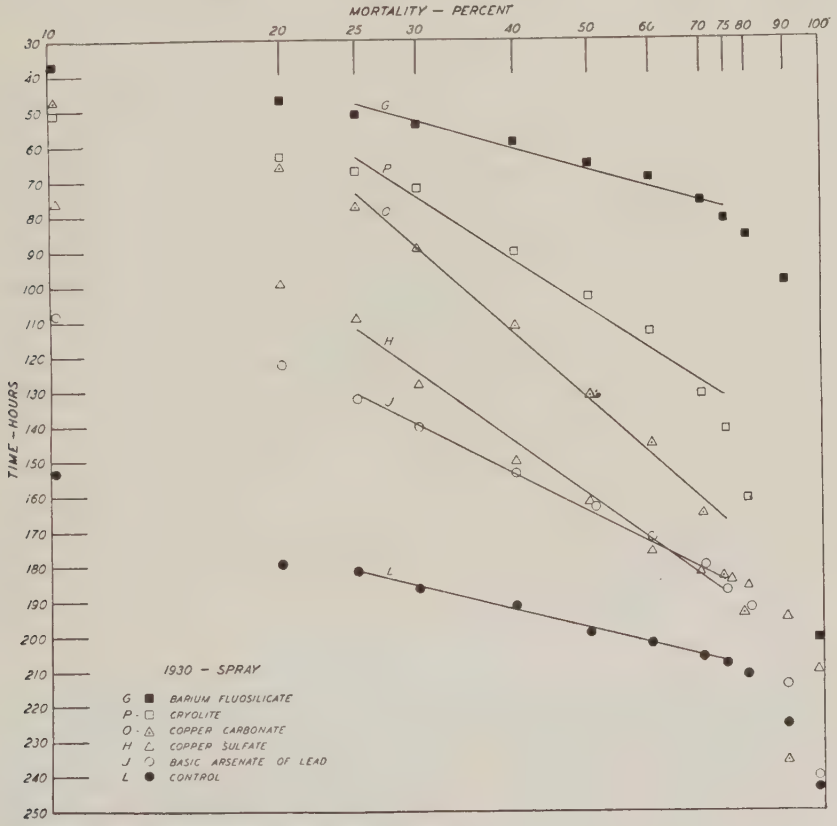

FIG. 4. After Boyce, Monthly Bull. Dept. Agr. Calif. 20: 687, 1931. Graphs showing relative effectiveness of various materials applied as sprays in 1930. The standard of comparison is the mean mortality period from 25 to 75 per cent. Data based on 55 experiments as in Fig. 3.

undiluted, giving the best results of the three and when used with mineral oil the toxicity was increased.

A dust combination of synthetic cryolite 20 pounds, Talc (fiber) 75 pounds and mineral oil 5 pounds gave 97.3% control, the highest obtained on any plot.

Synthetic cryolite and barium fluosilicate were tested extensively and although both are quite low in adhesive qualities the incorporation of fish oil, vegetable oil or mineral oil rendered them satisfactory in this respect. Of these the mineral oil proved most desirable.

In preparing a dust material, when diatomaceous earth is used as a diluent it has the decided advantage of being very light and bulky and the incorporation of oil for adhesive purposes does not affect its dusting qualities.

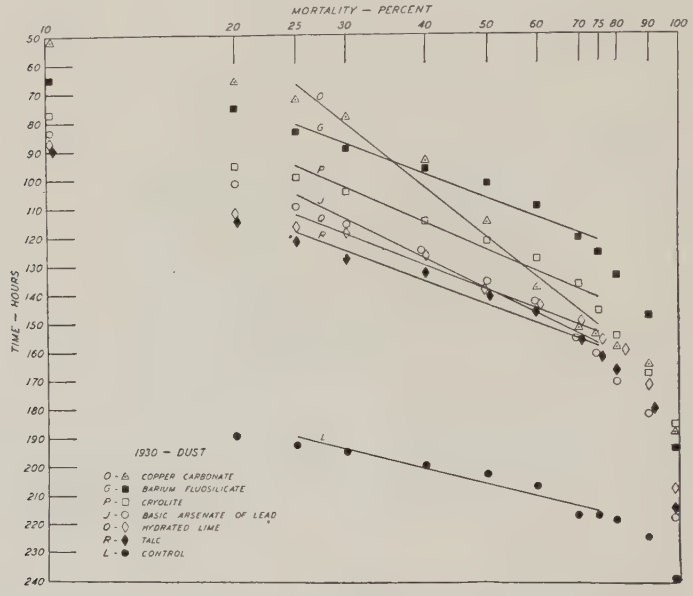
MORTALITY — PERCENT
10 20 25 30 40 50 60 70 75 80 90 100
TIME — HOURS
50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240
1930 — DUST
O - COPPER CARBONATE
G - BARIUM FLUOSILICATE
P - CRYOLITE
J - BASIC ARSENATE OF LEAD
O - HYDRATED LIME
R - TALC
L - CONTROL

FIG. 5. After Boyce, Monthly Bull. Dept. Agr. Calif. 20: 688, 1931. Graphs showing relative effectiveness of various materials applied as dusts in 1930. Standard of comparison and data of 55 experiments as in Fig. 4.

Mr. Boyce states that "satisfactory control of the walnut husk fly may be obtained through the use of synthetic cryolite (97+ per cent sodium fluoaluminate) or barium fluosilicate" and recommends the following formulae:

1. As a spray:

   Cryolite (synthetic) or barium fluosilicate, 3 pounds.
   Mineral oil (95 seconds viscosity, 90% unsulfonatable), 1 quart.
   Water, 100 gallons.
   Use from 30 to 40 gallons per average sized walnut tree. This affords satisfactory coverage.

2. As a dust:

Cryolite (synthetic) or barium fluosilicate, 30 percent.
Diatomaceous earth, 65 percent.
Mineral oil (95 seconds viscosity, 90% unsulfonatable), 5 percent.
The dust method is more economical.

The Natal Fruit Fly (Pterandrus rosa).

Similar results to those obtained by Boyce were obtained by Ripley and Hepburn (54) in toxicity studies dealing with the Natal Fruit Fly (*Pterandrus rosa*). They also found that in speed of action, natural cryolite was considerably inferior to the synthetic cryolite. The synthetic material

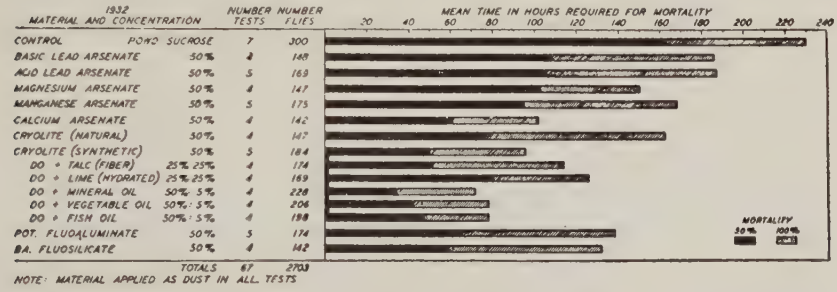
1932
MATERIAL AND CONCENTRATION
NUMBER TESTS
NUMBER FLIES
MEAN TIME IN HOURS REQUIRED FOR MORTALITY
20 40 60 80 100 120 140 160 180 200 220 240
CONTROL POND SUCROSE 7 300
BASIC LEAD ARSENATE 50% 4 149
ACID LEAD ARSENATE 50% 5 169
MAGNESIUM ARSENATE 50% 4 147
MANGANESE ARSENATE 50% 5 175
CALCIUM ARSENATE 50% 4 142
CRYOLITE (NATURAL) 50% 4 147
CRYOLITE (SYNTHETIC) 50% 5 184
DO + TALC (FIBER) 25% 25% 4 174
DO + LIME (HYDRATED) 25% 25% 4 169
DO + MINERAL OIL 50% 5% 4 228
DO + VEGETABLE OIL 50% 5% 4 206
DO + FISH OIL 50% 5% 4 198
POT. FLUOALUMINATE 50% 5 174
BA. FLUOSILICATE 50% 4 142
MORTALITY
50%
100%
TOTALS 67 2703
NOTE: MATERIAL APPLIED AS DUST IN ALL TESTS

FIG. 6. After Boyce, Jour. Eco. Ent. 26: 821, 1933. Results of toxicity studies in 1932, showing relative mortality of various materials in comparison with different combinations of synthetic cryolite.

may be more effective because the bond between the elements of the molecule is not as great as in the natural product, thereby liberating the fluorine more readily.

Grape Berry Moth.

Runner (59) experimenting in Ohio found that cryolite and Potassium fluoaluminate failed to control the grape berry moth and in some cases caused injury to the grape and also to certain vegetables.

The Apple Curculio (Tachyterellus quadrigibbus).

Hammer of New York (28) carried on experiments to control this pest and found that cryolite used at the rate of 6 pounds to 50 gallons of water gave a high percentage of control (74 dead and 3 alive out of 100 released). Also he liberated curculios on a caged tree sprayed with cryolite and found only 12 apples out of 533 were injured by feeding. Lead arsenate gave slightly better control.

The Mexican Bean Beetle—Epilachna Corrupta.

Since the bean plant is quite sensitive to the effects of arsenate of lead and is easily injured, it has been difficult to secure a material which would give high toxicity of bean beetle without injuring the plant. For several years Magnesium arsenate has been recommended and used as a control measure but magnesium arsenate is not a generally used insecticide and is consequently difficult to obtain in many states or regions where the bean beetle is a pest.

Howard, Brannon and Mason (32) of the United States Dept. of Agriculture Bureau of Entomology working in Ohio and Virginia have used fluorine compounds rather extensively over a three year period as substitutes for the arsenicals. They have found sodium fluosilicate to be too injurious to bean foliage and not sufficiently toxic to kill the insect. On the other hand synthetic cryolite proved very effective for controlling this pest and increased the yields in the great majority of the experiments appearing to be beneficial to the bean plant. Under conditions of light infestation when used at the rate of 1 pound to 50 gallons and 2 pounds to 50 gallons excellent results were obtained. When used under conditions of heavier infestations at a strength of 1 pound to 50 gallons it was not as good as Magnesium arsenate at the same strength, but at the rate of 2 pounds to 50 gallons it gave equally good results as Magnesium arsenate at the same strength. When used at the rate of 3 pounds to 50 gallons results were sometimes better than magnesium arsenate 2 pounds to 50 gallons. As a dust it is not entirely satisfactory but gave better results than an 80 per cent barium fluosilicate used under the same conditions.

Cryolite is apparently less injurious to foliage and safer than Magnesium arsenate especially in dry seasons and may in the near future be recommended by scientific workers in preference to it because of recent injury and lack of toxicity encountered in using magnesium arsenate and because cryolite is becoming more generally used and is available in most agricultural areas.

The Maize Stalk Borer (Busseola fusca Fall).

This pest is important in South Africa and has been studied by Ripley and Hepburn. They report (53) that cryolite gave

satisfactory control of the stalk borer as a spray at a 1-600 (by weight) strength. Although causing slight burning to the plant, it had the advantage over derris products of being a stomach poison and larvae need not necessarily be hit by it in order to be killed. It is also cheaper than derris products. In a later paper (55) they reported that cryolite when used on maize at the previously recommended strength and where 75 per cent of the stalks were infested even when applied a week late gave sufficient control of stalk borers to increase the yield of grain 26 per cent by weight. Cryolite being non-volatile remains in the plant until washed out by rain and when soap is added at the rate of 1 pound to 20 gallons the penetrating power and toxicity are increased. Synthetic cryolite appears to be the most satisfactory stomach poison, although contact insecticides like derrisol have given good results and are recommended.

A Garden Caterpillar (Polia (Mamestra) Oleracea).

Speyer (71) made tests with various materials including several fluorides in an attempt to control a garden caterpillar (*Polia (Mamestra) Moleracea*). Arsenate of lead cannot be used on tomatoes in bearing. Sodium fluoride injured the foliage. Barium fluosilicate had no effect on the larvae and no injury to the foliage. Aluminum silica fluoride was toxic to the larvae and did not injure foliage but the cost was too high. The most satisfactory results were obtained with synthetic cryolite in the form of a very fine powder used at the rate of 6 pounds to 100 gallons of water with the addition of 2 ounces of saponin as a spreader. The action may be largely a contact.

The Wattle Bagworm (Acanthopsyche junodi Heyl).

Ripley and Petty (56) worked with dust materials in an attempt to control the wattle bagworm in South Africa. Field and laboratory results on the basis of relative toxicity show them to be in the following order, the most toxic first:

1, Paris Green; 2, Sodium ferric fluoride; 3, Sodium fluosilicate; 4, Natural and synthetic cryolite; 5, Calcium arsenate; 6, Barium fluosilicate; 7, Calcium fluosilicate; 8, Schweinfurth yellow; 9, Copper carbonate.

Although showing greater toxicity the first three of these are usually dangerous from the standpoint of foliage injury while cryolite which gives a high toxic value among this group

is safer than any in the list with the possible exception of barium fluosilicate and certainly much safer than the first three.

Grasshoppers.

In using cryolite as a toxic material in grasshopper baits, Richardson and Thurber (57) found cryolite was not as toxic as arsenate of lead. The work of Marcovitch (41) also showed that cryolite gave rather poor control in the form of a bait.

Turnip webworm (Hellula undalis F.).

Robinson of Alabama (18) working on this pest showed that cryolite was effective in killing all the larvae of this species under experimental conditions.

The Tobacco Hornworm. (Protoparce quinquemaculata).

Marcovitch and Stanley (42) used lead arsenate, cryolite, barium fluosilicate and potassium fluosilicate in comparative tests against tobacco hornworms and found cryolite to give almost complete control of this pest with lead arsenate and barium fluosilicate giving almost as good control in the order named.

Shade Tree Pests.

The Bagworm (Thyridopteryx ephemeraiformis); The Fall Webworm (Hyphantria cunea); and the White Marked Tussock Moth (Hemerocampa leucostigma).

Tests made upon these three very important shade tree pests in Ohio by the author have shown that they can be very effectively controlled by Cryolite and without injury to the foliage of the Maples, Elm, Oak and other common shade trees and ornamentals which these usually attack. (Unpublished data.)

CONCLUSIONS.

The foregoing summary of literature and experimental work would indicate that:

1. Synthetic cryolite is superior to natural cryolite and in view of its physical and chemical properties is well adapted to insecticidal work.

2. Experimental work has indicated that cryolite has a relatively high toxicity to insects and gives the minimum of plant injury when properly used.

3. Fluorine when added in chemical form to food materials or injected into body tissues has given indication of chronic effects but other experiments conducted in a similar manner have given contradictory results. Also there is no available data regarding the effects of fluorine when plants sprayed with materials containing it were used as the source of food. Furthermore all experimental work to date has been performed with the soluble neutral fluorides and there is no data available upon the use of the insoluble fluorides although tolerance figures are placed upon these latter materials upon the basis of experimentation with the more soluble forms.

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First International Congress of Electro-Radio-Biology.

For the purpose of instituting among physicists, chemists, biologists, and physicians a close and profitable collaboration, indispensable for the advance of radio-biology considered not as a branch of radiology or of biology, but as a separate science in itself, the International Society of Radio-Biology is now preparing the organization of the First International Congress of Electro-Radio-Biology, which is to take place in Venice, in the Ducal Palace, in September, 1934, under the Presidency of H. E. Count Volpi di Misurata, Minister of State.

Plant Viruses.

The authors bring together in this interesting discussion what is known today regarding plant viruses. They discuss the appearance and symptoms of virus effected plants, size of organisms and reactions of viruses to physical stimuli, and the relation of insects to the transmission of virus diseases as well as transmission in general, such for instance as those caused by grafting, by contact, either foliage or root, through seed or by pollen. Other problems discussed are virus classification, plant resistance, or immunity to virus diseases, the movement of virus in the plant and the metabolic conditions of both the viruses and the hosts affected by them. One of the important and interesting phases of this treatment is the discussion of methods and apparatus or equipment used in handling and transmitting viruses. In addition to summing up the work performed this will aid the research worker in further studies and help him determine the trend of research in this very important field. The illustrations and diagrams are very helpful in the explanation of methods and apparatus.—D. M. DeLong.

Recent Advances in Plant Viruses, by Kenneth M. Smith and F. T. Brooks. 423 pp. Philadelphia, P. Blakiston's Son & Co., Inc., 1934.